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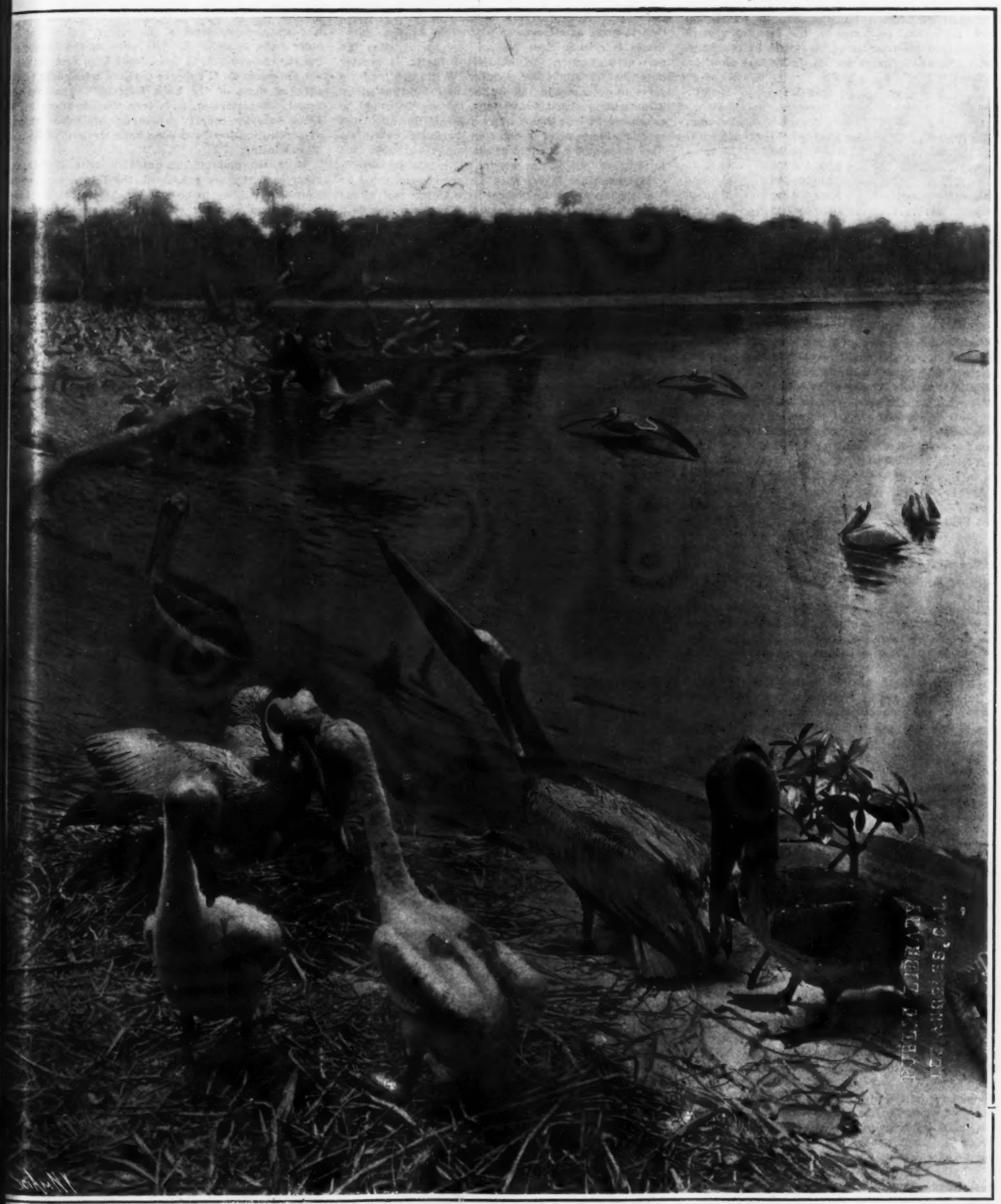


A GROUP OF BROWN PELICANS FROM PELICAN ISLAND, INDIAN RIVER, FLA., MOUNTED AT THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK. THE SETTING IS A FAITHFUL COPY OF THE ACTUAL SCENE ON THE ISLAND.

THE FIGHT AGAINST EXTERMINATION.—[See page 168.]

IRON ORE RESERVES.

WHEN WILL THE WORLD'S IRON SUPPLY GIVE OUT?

BY CHARLES KENNETH LEITH, PROFESSOR OF GEOLOGY, UNIVERSITY OF WISCONSIN.

THE great increase in the world's annual consumption of iron, together with the attempts of large interests to acquire the known iron ore reserves, have led to careful inventories of the world's supply of iron ore, its rate of depletion, and to speculations as to further supplies. Estimates of the time of exhaustion of the present known supply have varied widely, but have shown startling agreement in the short time assigned.

Prof. Törnebohm estimates for the Swedish government the iron ore reserves of the world by countries, based on detailed figures for the individual districts, as follows:

Country.	Iron Ore Reserve. Tons.	Metallic Iron. Per cent.
United States	1,100,000,000	45 to 67
Great Britain	1,000,000,000	25 to 34
Germany	2,200,000,000	30 to 45
Spain	500,000,000	40 to 56
Russia and Finland	1,500,000,000	20 to 65
France	1,500,000,000	.....
Sweden	1,000,000,000	50 to 70
Austria-Hungary, Other countries	1,200,000,000	.....
Total	19,000,000,000	.....

Many will be surprised at the high figures given for the reserves in Great Britain and European countries. So much is heard of our own vast reserves and of the low grade of some of the foreign ores that we have come to think of the supply outside of North America as relatively small. The position of the United States is somewhat better than shown in the table when we take into account the grades of ore. By multiplying the figures by the average percentages of metallic iron given for each of the countries by Prof. Törnebohm the result is as follows:

Country.	Metallic Iron. Tons.
United States	603,166,600
Great Britain	295,000,000
Germany	825,000,000
Spain	249,375,000
Russia and Finland	637,500,000
Sweden	611,538,460

It is believed that the reserves for the United States, and hence the total, are higher than indicated in this table, but before taking up this question we may consider conclusions that may be drawn from the figures as they stand.

President Hadfield, of the British Iron and Steel Institute, has prepared a diagram, showing the world's increase of pig iron consumption since the fifteenth century and the projection of this rate for the next century on the rate of the last thirty years. If the same rate of increase holds for the next century as has held for the last thirty years, in the year 2000 the world's annual consumption of iron will be three and one-fourth times its present consumption. The total world's supply of iron ore now known, given as 9,000,000,000 tons by Törnebohm, will be exhausted in about fifty years. If the total be correct, about one-fourth of the world's known reserves have been used to the present time. It is argued that the calculated rate of increase is not improbable because of the increased rate per capita of the countries now using iron, because of the normal increase of the population of these countries and because of the extension of the uses of iron through a much larger proportion of the world's population than now uses it (12½ per cent). If 38 per cent of the world's population were to require iron in the year 2000, this would account for the calculated increase of consumption. However, this additional part of the world's population, especially in Asia, may find its own iron ore supplies. No one would doubt that the world's reserves will be greatly increased by new discoveries in these relatively unexplored parts of the world.

Judging from the history of the development of the iron ore industry to the present time the reserves of unexplored countries are likely to be developed only so fast as the population requires it. In this case such new discoveries will not figure in the reserves available to the countries at present producing iron ore. The generalization might perhaps be made that each continent must ultimately depend on its own resources of iron ore and cannot count, to any large extent, on drawing supplies from any other parts of the world.

It is of interest to apply the same method of calculation used for world's supply and consumption to the United States. If the rate of increase of consumption be projected for the next one hundred years on the basis of the increase for the past thirty years—that is, the period used by President Hadfield, and the lines superposed upon his diagram—it would appear that the rate of increase of production for the United States is greater than that of the world. Also the rate of production for the United States is greater than that of any other country. With the total reserve of iron ore in the United States estimated by Törnebohm at 1,100,000,000 tons, the supply would be exhausted in less than twenty years if the calculated rate of increase of production holds. Dr. William Kent calculates a pig iron production of 67,340,000 tons in the year 1920 on the basis of the rate of increase of production since 1880. With the reserve estimated by Törnebohm, up to the present time 39 per cent of our total supply has been used, and 29 per cent has been produced during the last thirty years.

The late Edward Atkinson estimated that if the per capita consumption remains the same the average annual increase in population of 2,000,000 for the United States calls for a yearly increase of pig iron of half a million tons, and that when the probable increase in per capita consumption is taken into account the total production of the United States will increase at a considerably greater rate.

Prof. Shaler concludes that the iron ore supplies of the United States are not likely to last for more than a century, and others have reached similar conclusions as to the relatively early exhaustion of the ore deposits, few venturing to predict a longer life for the known deposits of more than one hundred years. The strenuous efforts of larger interests in recent years to secure ore deposits and to explore ore-bearing fields are evidence that the possibility of the early exhaustion of the ores is appreciated by many of the companies most concerned. The situation is probably not so unfavorable as the above estimates would indicate. The assigned rate of increase of production may be too great, for the development of the iron industry of the United States for the past thirty years has been a phenomenal one. On the other hand, it is scarcely safe to predict a lessening rate of increase, for during the past fifty years it has been thought many times that the increase of rate was checked.

Törnebohm's estimate of the total reserves of iron ores for the United States is very conservative, and probably should be greatly increased. His estimate is confined to the producing districts and leaves out of account many important extensions of the ore deposits and districts, many known deposits of good size and quality not now mined because of location or other causes, and large reserves of ore which in the United States are regarded as too low grade to be of present commercial value, but really of a higher grade than ores counted in the English and German reserves. There should also be included the iron ore resources of Canada and Mexico immediately adjacent and accessible to the United States, already largely controlled by American capital and probably to be used in part in the United States.

The ultimate iron ore resources of North America are still far from known, but there may be no harm in reviewing our present imperfect state of knowledge concerning them. A great bulk of the known reserves of the United States is in the Lake Superior region. Törnebohm assigns a billion tons to the Lake Superior regions, and these figures, while probably small, are in accord with many current estimates. In the producing Lake Superior iron districts exploration has, for the most part, been sufficiently thorough to make it certain that no large increase of reserves is to be expected. In the Mesabi Range, for instance, 30,000 drill holes and pits have been sunk. The Lake Superior iron districts, however, make up but a small proportion of the region tributary to Lake Superior, constituting less than 4 per cent of the land area included in the United States Geological Survey's map of the Lake Superior region. In the remaining 96 per cent there are still large possibilities for finding iron ores. The greatest of the ranges was discovered as late as 1891, and within the last five years two entirely new ranges have been found, though neither of them yet of the first importance. The geological conditions are such as to warrant the belief that more may be found. At the present time exploration in areas intervening between the ranges and in outlying areas is being pushed vigorously, showing the faith of iron men in further possibilities in this direction. The most sanguine, however, would scarcely hope to find ores equal in amount of those already known. Lake Superior geological conditions are known to extend northward and northeastward through Ontario, suggesting an important source of supply here. The present known iron ore supply of this great region, counting even ores of low grade, does not equal the reserves of one of the older Lake Superior districts, such as the Marquette, but the country still to be explored is so vast that it is not unreasonable to suppose that important iron ranges such as those of the Lake Superior region may be found. Nevertheless, it is true that nowhere in the Lake Superior country where an equivalent amount of exploration has been done have the results been so disappointing.

When the present high-grade deposits of this and other countries are exhausted, the future demand for iron ore is likely to be met by the use of far lower grades than are now considered commercially profitable. The term "ore" is a relative one. With the conditions in Alabama a rock containing 36 per cent metallic iron may be mined as ore, while in the Lake Superior country such rock is now of no value as an ore. The ferruginous cherts and jaspilites, making up 95 per cent or more of the iron formations of the Lake Superior region, average between 25 and 35 per cent in metallic iron, and show all gradations into the iron ores. At the present time ores running below 45 per cent are but rarely shipped. If the time should come when 30 per cent ore could be used under the Lake Superior conditions, the tonnage available would be something enormous, perhaps twenty or more times as great as the present supply. It should be remembered that these ores are high in silica, and therefore not as desirable as ores of the same metallic content containing calcium carbonate in the gangue, as do the Alabama ores. Moreover, the great distances from blast furnace centers, on the assumption that these remain approximately fixed, will put the low-grade Lake Superior ores to a disadvantage in the matter of the cost of transportation.

Törnebohm estimates the amount of ore now available in the southern Appalachians at 60,000,000 tons. The Clinton red hematites make up the bulk of this tonnage. Drilling has shown that the presently worked deposits extend with slightly leaner but uniform composition in thin, even beds over enormous areas, and it is altogether likely that the tonnage of these ores is many fold the figure given. The ores are low grade, and the cost of mining will greatly increase when the larger reserves are tapped.

The Clinton ores extend along the Appalachians into New York and appear again in Nova Scotia and Newfoundland. In each of these localities extensions are likely to be found. At Belle Isle, Newfoundland, approximately 30,000,000 tons of iron ore are available. This body is known to extend under the ocean, and if it can be successfully mined there, a large additional tonnage may be secured.

The brown ores of the eastern United States are difficult to estimate. They are usually low grade, mixed with clay, and often lie in thin and irregular beds, but the aggregate amount is large.

The magnetites of the Adirondacks and New Jersey are not included in Törnebohm's figures. Here again the tonnage is large, and if attempts at magnetic separation are successful on a large scale, as they seem likely to be, we have here another important source of iron ore which has not been taken into account in these estimates. The titaniferous magnetites will be another important source of supply when they can be profitably smelted.

Unexploited iron ore deposits are widely distributed in the western United States, and extravagant estimates of tonnage have been reported, frequently due to the fact that the basis of comparison has been the comparatively small size of the precious metal deposits of the West. The writer has examined deposits of reputed large size where the true tonnage seemed to him to be measured in units of thousands rather than millions or tens of millions. The grade of these deposits is on the average not high as compared with Lake Superior deposits, and there is frequently a high percentage of phosphorus and sulphur. Nevertheless, there is in the aggregate through the Western States a very large tonnage of iron ore of present commercial grade.

With few exceptions the western ores occur along the contacts of intrusive igneous rocks and limestone,

* Abstracted from Economic Geology.

and the extent to which the ores follow the contact in depth has not been shown. Hence, the estimates of tonnage vary within very wide areas. The iron ore deposits of Iron County, Utah, are among the larger and most typical of this class of ores. Here some eight hundred pits have been sunk, and it has been possible in recent detailed mapping to estimate with a reasonable approach to the truth the amount of ore of all grades appearing to the depth shown by explorations or natural exposures. Using the Utah deposits as a basis of comparison and excluding the Mexican deposits, which the writer has not seen, the tonnage of iron ore of all grades in each of the better known districts of the West and adjacent parts of British Columbia would not surpass that of one of the older Lake Superior ranges; but it is extremely likely, as deep exploration of the presently known deposits continues and as further deposits are found, as they undoubtedly will be, that the aggregate tonnage of ore in the West will equal a considerable part of that of the Lake Superior region, and one would be rash to conclude that it is impossible that an amount of iron ore may be found in the West fully equivalent to that in the Lake Superior region.

If these data approximate the truth, there seems to be little cause of alarm that North America will really suffer for lack of iron ore for a considerably longer period than required for the exhaustion of the presently known tonnage, as estimated by Törnebohm and others, at the present rate of increase of production. The time of exhaustion is not likely to come before that calculated on the same basis for the world's reserves, and probably not then. It may be argued that the use of lower grade ores in Europe and England than in the United States is itself evidence that the exhaustion of reserves is further in the future for the United States than for Europe or England. But as it becomes more and more obvious that the end of the supply of higher grade ores in the United States is not indefinitely in the future, and may even be within a single lifetime, there is likely to be an increase in the tendency to conserve the higher grade ores, and especially the Bessemer ores, and draw more largely on the lower grade supplies, a tendency favored by the concentration of control in a few hands. This tendency has already become well defined, as shown by the fact that pig iron production has not in recent years increased as rapidly as iron ore production. It is not at all unlikely that even the next decade may see important changes in this direction. This will give value to properly located low-grade ores. It will ultimately mean higher cost for iron changes in the relative importance of processes for conversion of iron, possible changes in the geographic distribution of different phases of the iron industry, and a modification of the relations of the North American iron trade with that of the rest of the world.

MERCURY AND INTRAMERCURIAL PLANETS.

A REVIEW OF THREE CENTURIES OF STUDY.

BY ABBÉ TH. MOREUX, BOURGES OBSERVATORY.

IT appears almost incredible that, in the twentieth century and after the diligent labor of Le Verrier, the theory of the motions of Mercury should remain an unsolved problem. Yet such it is, to speak strictly, for after nearly three centuries of study we have reached only an approximate solution.

If the orbit of Mercury, which lies within that of the earth, were exactly circular and in the plane of the ecliptic, a transit of Mercury across the sun's disk would occur once in each synodical revolution and the epoch of the transit could be calculated very easily. But the orbit is inclined 7 deg. to the ecliptic and is very eccentric. In order to predict transits it is necessary to find common multiples of the sidereal revolution of the earth and the sidereal and synodical revolution of Mercury, and to find from the tables of Mercury and the sun the precise relative positions of those bodies at the epochs thus determined.

This very complex calculation was first attempted in 1627 by Kepler, who, after constructing the Rudolphine tables based on the observations of Tycho Brahe, predicted a transit of Mercury on November 7, 1631, allowing a possible error of about one day. As a matter of fact, the transit took place in 1630, a few days before Kepler's death, and was observed and projected on a screen by Gassendi. After the transits of 1661 and 1677 La Hire constructed new tables of Mercury and predicted a transit on May 5, 1707. The calculation was in error by nearly a day. After the transit of May, 1753, had been observed several hours later than La Hire's and as much earlier than Halley's prediction, Lalande constructed new tables, and predicted the transit of 1786, which actually took place fifty-three minutes later than the time announced by Lalande and about as much earlier than the time computed by Halley's tables. Lalande then corrected his tables and predicted the transits of 1789, 1799, and 1802 with a fair approach to accuracy. The tables compiled by Lindenau, in 1813, still left much to be desired.

The problem was in this condition when it was attacked by Le Verrier, who was under no illusion in regard to its difficulty. In 1843 Le Verrier presented to the French Academy "A New Determination of the Orbit and the Perturbations of Mercury," but his tables were not satisfactory, for in 1849 he wrote: "The invariability of the mean motions of the heavenly bodies has served as a basis of observation for two thousand years and this basis has acquired the character of mathematical certainty through the labors of French geometers, who have proved that the mutual attraction of the planets does not alter their mean motions. This is one of the conditions of stability of our planetary system. Hence I was greatly surprised when, in working on the theory of Mercury, I discovered that the mean motion of that planet, deduced from the observation of the last forty years, was much smaller than the value derived from the comparison of ancient and modern observations . . . and my efforts to construct a theory free from this discrepancy have hitherto been fruitless."

Le Verrier did not succeed in overcoming these difficulties until 1859.

The anomalies observed in the motion of Mercury can be explained either by supposing that too small a mass has been assigned to Venus or by assuming the existence of one or more disturbing bodies between Mercury and the sun. On the first hypothesis Le Verrier found that an increase of one-tenth in the mass of Venus would account for all the irregularities. But here arose a new difficulty, for Venus attracts the earth as well as Mercury and, the theory of the earth's motion being known and unquestionably accurate, it was impossible to admit that too small a mass had been assigned to Venus in constructing that theory. Being thus restricted to the second hypothesis, Le Verrier assumed the existence of a single intramercurial planet and formulated the relation that must obtain between its mass and its distance from the sun. Observation, however, appeared to furnish no physical evidence to support this mathematical demonstration. No intramercurial planet had been indubitably seen in transit across the sun or during a solar eclipse.

"Such," says Le Verrier, "are the objections that can be made to the hypothesis of a single planet, comparable in size with Mercury and revolving within the orbit of the latter planet. Those to whom these objections appear insurmountable are compelled to replace the single planet by a number of asteroids the combined attractions of which would produce the same effect on the perihelion of Mercury. These asteroids would not be visible in ordinary conditions and, owing to their distribution around the sun, they would not introduce any considerable periodic inequality in the motion of Mercury. The hypothesis to which we are thus led is not extravagant. Between Jupiter and Mars we find a group of asteroids, of which, no doubt, only the principal members have been discovered. Indeed, there is reason to believe that the interplanetary space contains a vast number of very small bodies which revolve around the sun. This is certainly true of the region near the earth."

Le Verrier concludes by recommending attentive and regular observation of the solar disk for the purpose of discovering such asteroids as may be large enough to be visible in transit.

In December, 1859, soon after the publication of this theory, a physician named Lescarbault informed Le Verrier that in March of that year he had seen the sun crossed by a well-defined, round, black object, the diameter of which appeared less than one-fourth that of Mercury as he had observed that planet at the transit of 1845. From the data furnished by Lescarbault, Le Verrier calculated that this body, to which he gave the name Vulcan, revolved about the sun in 19 days and 7 hours, and that its mass could not be greater than one-seventeenth of that of Mercury. Twenty similar and similarly situated masses would be required to cause the observed irregularities.

The curiosity of astronomers having been awakened by these publications it was remembered that similar observations of transits had been reported at various times. Wolf, Haase, and Carrington have found a score of passages in astronomical records which may relate to transits of intramercurial planets.

In 1876, after an observation of this kind had been made by Weber, Le Verrier undertook the discussion of all the cases then known in which the motion of the object over the disk of the sun had been clearly determined. Only ten observations appeared free from doubt and the discussion of these cases led Le Verrier to an indeterminate solution of the problem. The observations could be explained equally well by any one of four different orbits for the intramercurial planet, but the most probable orbit corresponded to a period of revolution of 33 days. Assuming this orbit and period Le Verrier predicted transits on March 22, 1877, and October 15, 1882, but no transit was observed on either of those dates.

Two years later Prof. Watson of Ann Arbor announced that he had photographed two intramercurial planets during an eclipse of the sun. Examination of the photographs showed that the supposed planets were probably two small stars of the constellation Cancer. Gaillot proved that the orbit calculated from the photographs for one of the bodies could not be the orbit of a planet, and Oppolzer, repeating Le Verrier's calculations and including two additional reported transits, obtained an orbit that could not apply to either of the bodies discovered by Watson.

It appears, then, that the hypothesis of a single intramercurial planet must be abandoned. Not only has no such body ever been seen beyond a shadow of doubt, but from a mathematical point of view it is impossible to admit that a single body can produce the observed perturbations. This hypothetical planet could not have failed of discovery in the numerous researches that have been made during so many years. What, then, is the true explanation of the perturbations?

I will conclude this sketch by suggesting a hypothesis which I have already formulated in my book, "The Solar Problem." The sun is unquestionably surrounded by matter which gives rise to the observed phenomena of the corona.

Photographs made during the eclipse of 1905 showed an outer corona extending to a hitherto unsuspected distance from the sun. This outer corona is ellipsoidal and its major axis is very nearly coincident with that of the zodiacal light. This region, then, is filled with a resisting medium, composed of matter which is gradually falling in toward the sun. The mechanism of this fall, or contraction, is very complex, and as we have no idea of the density of the matter it is difficult to calculate its changes in form.

The resistance which the medium opposes to a moving body is likewise difficult to estimate, but we know from the observed accelerations of comets that this resistance is by no means negligible. At the epochs of maximum coronal development this resisting medium may easily extend to the orbit of Mercury. Hence that planet in its revolution around the sun must traverse masses of rarefied gas and swarms of minute particles by which its course is modified. We are far from knowing the quantitative effect of the resisting medium and much study of the corona will be required to complete the solution of this interesting problem.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Cosmos.

OUR LEGION NEWSPAPERS.

IN Appleton's Magazine Gen. Charles H. Taylor, editor of The Boston Globe, discusses "The Newspaper as It Is To-day." After referring to the fact that statistics of American newspapers were first compiled in 1810, when there was a total, of all kinds, of 366 newspapers—25 dailies, 36 semi-weeklies, 15 tri-weeklies, and 290 weeklies—he gives the latest available figures, which show that in 1907 there were 21,535 newspapers, reviews and such, of which 2,415 were dailies, 16,288 weeklies, 2,655 monthlies, and 177 quarterlies. He comments as follows:

This almost fabulous increase in the number of papers published has been accompanied by a still greater increase in the number of copies issued by each paper. The combined circulation of the press of the United States for 1907 could not have been less than ten billions of copies. The latest available figures on circulation, those given in the census of 1900, show that in that year the total number of all news-

papers printed in the United States was 8,168,148,749. These figures show an increase over 1890 of 74.5 per cent, while 1890 had shown the remarkable increase over the decade before of 126.4 per cent.

The subscriptions and sales of the country's newspapers for 1900 brought them in $79,938,483, while advertising brought in $95,861,127 more, making the handsome total income from these two main sources of $175,179,610. At the recent rate of increase in circulation and advertising the present year's should be full 20 per cent additional, or more than $200,000,000.

Gen. Taylor says there was never a period when a reader got so much for his money as now, adding:

"Of a popular sporting event of which the public demands full reports, the papers now print more columns than the oldtime papers printed lines. For example, most of the leading New York and Boston papers devote from two to three pages to an 'America's' Cup race. . . . On the other hand, when the cup was won by the 'America' at Cowes in 1851 the New York and Boston papers were content to print, a fortnight after the event, insignificant paragraphs of 250 to 500 words each about her victory. When Lincoln was nominated for the Presidency in 1860 one telegraph operator sent all the press matter filed at the Wigwam, in Chicago. In a national convention to-day one company alone has fully one hundred operators."

ANCIENT BABYLON.*

THE PROGRESS AND RESULTS OF THE GERMAN EXPLORATIONS.

BY PROF. FRIEDRICH DELITSCH.

THE reconstruction of the topography and the exploration of the remains of ancient Babylon were undertaken in 1898 by the German Oriental Society, with the financial support of the German government, and there is every probability that the great task will be carried to a successful conclusion.

The site of Babylon is an extensive field of ruins, of which the greater part lies on the left or east bank, and the remainder on the west bank, of the River Euphrates. In the north end of the field is the great pile of ruins, nearly 100 feet high, which is still known as Babil, and which has not only marked the site, but even preserved the name of the ancient city through the centuries.

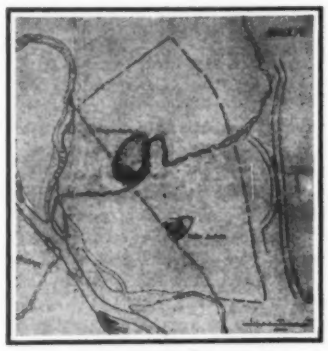
In the middle of the west side of the field, near the river is the pile called Kasr, or the Citadel, less than 50 feet high, but of vast extent, the identity of which with the palace of the Chaldean kings has never been doubted. A little farther south lie the ruins called Amram ibn-Ali, now positively identified with the great temple of Marduk, called Esagila.

A general idea of the ancient city and, in particular, of its extent and the length of its walls, was derived long ago from numerous inscriptions, of which the first discovered and the most important is the

MAP OF ESAGILA, THE HILL OF RUINS.

great stone tablet bearing an inscription of ten columns and more than 600 lines, which is in the East India House in London. From these inscriptions it was inferred that the west walls of both palace and temple were washed by the Euphrates, on the other side of which extended a residential section of little importance, which was protected only by a wall of earth.

Three inscriptions agree in stating that Nebuchadnezzar built a mighty wall and moat 4,000 yards east of the city of Babel and inclosing it on the east, for the protection of the city, the temple Esagila, and "Imgur-Bel, the wall of Babel." The moat was excavated to the ground-water level, the bank was paved with bricks and asphalt, and thereon was built a wall "mountain high" with great gates of cedar covered with copper. Evidently this wall of Nebuchadnezzar was the outer wall of the city, of which the ruins can be traced along a line which extends for a length of 3,600 feet around the mound Babil, runs thence more than two miles in a southeasterly direction, and then bends at right angles and runs southwest nearly two miles to the ancient shore of the river, south of the city. In another inscription, Nebuchadnezzar records the erection of a castle to guard the city on the north, on land protected against inundation by a great wall of bricks and asphalt. The castle was built of the same materials, "mountain high," and roofed with great beams of cedar. The doors were made of cedar sheathed with copper, the sills and hinges of bronze. This castle or palace was the vast structure whose ruins from the mound Babil in the northeast angle of

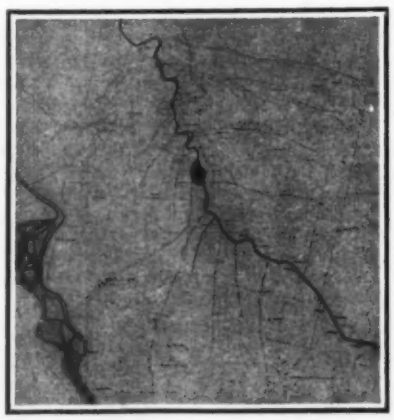


MAP OF NINEVEH.

the city wall. On the west side of the mound is the great trench from which Nebuchadnezzar's river wall, more than 50 feet in thickness, was removed by a modern brick dealer, who made a fortune by the operation.

It is worthy of note that Nebuchadnezzar speaks of building his new eastern city wall in order that "no dart nor spear shall approach Imgur-Bel." Imgur-Bel was the inner wall. The name signifies "Bel hath been merciful." So a tower in Jerusalem was named Chanan-El, "God hath been merciful." The outer wall was called Nimitti-Bel, "Bel's Station." The former is designated as the *dur* (wall), the latter as the *saichu* (presumably outer wall) of Babel. Wherever the names Imgur-Bel and Nimitti-Bel, "the great walls of Babylon," appear—as they do even in inscriptions much earlier than Nebuchadnezzar—they refer to the two parallel walls, placed near together, which surrounded the old city on the north, east, and south for the protection, in particular, of the most important and valuable building of Babylon, the temple of Esagila, which was filled with treasures of every sort.

The exploration of the ruins of the long east wall was commenced in April, 1904, and soon brought to light a wall nearly 25 feet thick, built of clay bricks, and fortified by bastions 29 feet long placed about 60 feet apart. On the east side all the bastions protrude 11½ feet from the wall, but the protrusion on the west side is alternately 2.3 feet and 4.6 feet. In December of the same year part of a second bastioned



OPPERT'S MAP OF BABYLON.

wall, a little distance east of the first wall, was uncovered, and in or near it were found two clay cylinders bearing identical inscriptions, which referred to this outer wall by the title Nimitti-Bel. The inscription, which contains twenty-eight lines, begins with a dedication to Marduk, the creator of heaven and earth, the lord of Babylon, dwelling in the temple Esagila, and then records the titles and genealogy of the ruler Asurbanipal, glorifies his good work in the restoration of the city and the worship of Marduk, and concludes with the statement that the monarch, finding both walls destroyed, first rebuilt the outer wall, Nimitti-Bel, in which the inscribed cylinders were imbedded.

Sanherib, Asurbanipal's grandfather, had destroyed Babylon in a fit of passion in 689 B. C., and his son and grandson rebuilt the city.

The ruins of the inner wall have been followed to the low-lying cultivated fields north of the city. Prof. Koldewey laid bare 1,600 feet of the outer wall, in which many inscriptions of Sardanapalus were found, and was about to continue the excavation southward, to the angle where the wall turns to rejoin the Euphrates, when that section of the wall was swept away by a flood.

Fortunately another large section of the double wall, which lay buried under a huge pile of ruins, has been discovered near the river. When Koldewey's exploration of the Kasr had resulted in the discovery of the south castle or palace, built by Nabopolassar and re-

OLD MAP OF BABYLON.

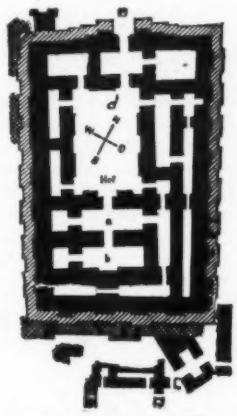
built and probably enlarged by his son Nebuchadnezzar, and also in that of Nebuchadnezzar's second palace, erected on a foundation of broken bricks a little farther northward, the writer felt confident that part of the double wall would be found beneath the debris that covered the space between these two structures. For the East India House tablet informs us that Nebuchadnezzar could not find room in Babel to enlarge his palace, and for that reason he erected a new palace beyond the outer wall upon a foundation of broken bricks. And when Andrae, in 1902, laid bare the Istar gates between the two palaces, it appeared almost certain that a double wall must have extended eastward and westward from the gates. This double wall was discovered in January, 1905. It has since been traced westward to the river and eastward to the Istar gates, and Prof. Koldewey is now preparing to follow its course eastward beyond the gates.

The evidence given above leads to the conclusion that the original city of Babel comprised an area of about three-fourths of a square mile, nearly square in shape and inclosed on three sides by a double wall, the fourth side resting on the river. But Assur, the earliest Assyrian metropolis was still smaller, covering less than one-third of a square mile. The importance of the walled city of Babel was due to the fact that it sheltered the national sanctuary of Esagila. The kings often visited in other cities of the land.

But when the dominion over Asia Minor had fallen to Babylon in consequence of the downfall of Nineveh, and Nebuchadnezzar had successfully defended his em-

* In Ueber Land und Meer.

pire against Egypt by his defeat of Pharaoh Nesho at Karkemish (605 B. C.), Nebuchadnezzar chose Babylon as his permanent capital. Then wealth and population flowed into the city, which soon proved too small for both sovereign and people, and Nebuchadnezzar added a "new city," as we learn from Berossos and also from the cuneiform inscriptions. The area of the en-



PLAN OF EMACH TEMPLE.

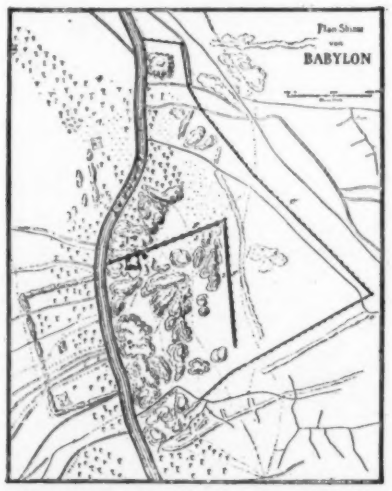
larged city was about 2.7 square miles, an extent which, though small according to modern ideas, exceeded the area of Nineveh and even that of Rome under the empire.

The knowledge of these facts disposes forever of the fantastic conception, which we owe to Herodotus and Jules Oppert, of a city as large as London and Paris combined, and five times as large as Greater Berlin, surrounded by a wall as high as a church steeple, 100 feet thick, 50 miles long, and pierced by a hundred gates.

The situation of Babylon, as revealed by the excavations and inscriptions, was precisely like that of Nineveh. The river formed the western boundary of each city, which was inclosed by walls on the north, east, and south.

Although the real Babylon was forty times smaller than the Babylon of tradition, its complete exhumation would be a task almost beyond human power, and one which it is neither possible nor desirable to attempt. The great mound Babil, comprising the ruins of Nebuchadnezzar's huge third palace or castle, is in the hands of brick gatherers, who hold a concession from the government, so that it will not soon, if ever, be available for archæological exploration. Furthermore, the greater part of the area of the city, which even as late as Nebuchadnezzar's reign preserved a semi-rural character and contained reed huts and farm yards, as well as paved streets and brick houses, is not likely to yield much of interest or value. Indeed, the only thing worth excavating in Nebuchadnezzar's new city is the great wall, which the Greeks regarded as one of the wonders of the world.

It will also be very desirable, though perhaps impossible because of the cultivation of the land surrounding the city, to find the Bit Akiti, or New Year festal hall, which, according to Nebuchadnezzar, was erected beyond the outer wall. Here many animals were sacrificed and great feasts were enjoyed on the first day of the year, and hither the procession in honor of the



PLAN OF BABYLON, SHOWING THE OLD CITY AND NEBUCHADNEZZAR'S ADDITIONS.

gods Marduk and Nebo moved along the Processional Way, part of which has already been laid bare.

At Assur, which is surrounded by a desert, our explorers have been fortunate enough to find the Assyrian Bit Akiti far beyond the north wall of the city. It is obvious that hecatombs of cattle and sheep and festal gatherings of the entire population could not take place within the city.

In the future, as in the past, however, our attention will be directed chiefly to the small old city which existed before the time of Nebuchadnezzar. For the last eight years Prof. Koldewey has been engaged in the exploration of the Kasr, that great heap of ruins on which the imperial palace at Berlin, with all its annexes and grounds, could easily find place. The Kasr has already yielded two palaces, a monumental gate, a temple, and many interesting objects.

The south palace of the Kasr comprises within itself a great group of buildings which sheltered a multitude of officials, retainers, and slaves, in addition to the royal family. The group is bisected by an alley which runs north and south. In all probability the western part, much of which has already been excavated, constituted the royal residence of Nabopolassar. The eastern part contains a labyrinthine complex of houses and three large courts, separated from each other by walls provided with gateways. The third gateway gave entrance to the royal court, which was bounded on the south by the north façade of the audience hall. This façade was more than 40 feet long, and was adorned with floral and other decorations in yellow, white, green, black, and two shades of blue. The audience hall measures 60 by 170 feet, and the alcove in which the throne was placed can still be traced on its southern side. Very little of the walls of the palace remain standing, but their places, and even those of the doors, are indicated by the foundation walls, which are very well preserved. The foundations were filled in with sand and broken bricks, for cellars were unknown in those days.

Nebuchadnezzar's second palace (in the northern part of the Kasr ruins, beyond or north of the double

OLD MAP OF THE HALL OF KASR. SOUTH AND NORTH CITADELS OF NEBUCHADNEZZAR.

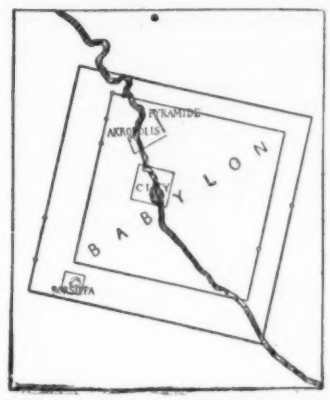
wall of the *old* city) was built on an artificial terrace of broken bricks raised 26 feet above the original level and 46 feet above the river. Hence it overlooked the south palace, the foundations of which were carried down to the ground-water level. A few of the massive foundation piers of this second palace were all that was visible of the old city before the excavations were commenced. The "hanging gardens" of Semiramis probably rested on the roofs of some of these palace buildings.

East of the second palace a section of the Processional Way ran between massive walls, the friezes of which showed a series of figures of lions, executed in relief in yellow and white or green and yellow enameled tiles. The roadway, paved with limestone blocks, was flanked by wide foot pavements of red breccia.

The Processional Way passed through the Istar gates, in the north double wall of the old city. These gates were flanked by great towers, and were the most ornate of all the gates of Babylon. Our excavation, carried down to the foundations at the water level, reveals the great height of these structures, which were gradually built up as the level of the Processional Way was raised by the accumulation of debris. The height of other buildings was increased for similar reasons. And as the towers rose, Nebuchadnezzar's standard of magnificence rose with them. The lower parts are adorned with figures of bulls and dragons in monochrome relief. The same designs are repeated above in flat enamel and, at a still higher level, in colored enamel in relief, like the lions of the Processional Way. These figures, which were imitated by Persian artists of a later period, can scarcely be equaled to-day.

Our excavations have proved that the Processional Way continued southward from the Istar gates to the great Esagila temple, but the entire route of the Marduk and Nebo procession is not yet determined. It appears to have started from richly ornamental vessels on the river by way of a canal northwest of the city, the mouth of which was discovered last year by Koldewey, but we do not know by what route it gained the Bit Akiti, or Hall of Sacrifice, and thence returned to the temple of Marduk by way of the Istar gates.

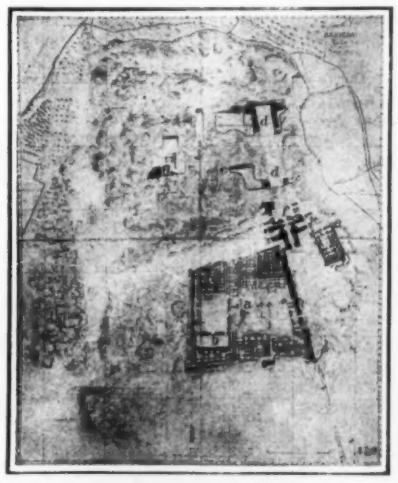
Prof. Koldewey has made plain every detail of the



OPPERT'S MAP OF BABYLON'S WALLS.

construction of more than one Babylonian temple. The characteristics of all are well shown by the small temple Emach, which has been excavated from the Kasr, southeast of the Istar gates, and which was consecrated to Nin-mach, the goddess of birth and mother of the gods. Before the main entrance stood an altar of clay bricks, covered with clay and with lime mortar, and surrounded by a paved court. Temple and court are inclosed by a massive brick wall. A gateway in this wall gives access to a vestibule which is flanked by two other rooms, of which one communicates only with the vestibule and the other only with the inner court. The court was paved with flagstones laid in asphalt, and contained a deep square well, of which part of the curb is still intact. The temple was built of unburned bricks laid in clay mortar, and was divided into a number of chambers and passages. In the rear wall of the innermost chamber, or sanctuary, was a shallow recess in which the image of the goddess evidently stood.

In 1901 the temple of Ninib, the Assyrian and Babylonian god of war, was discovered and laid bare in the southern part of the city. This also was built of unburned bricks, simply ornamented, and covered with lime mortar. Under the threshold were found two little vaults, each of which was constructed of four tiles set on edge with a fifth tile laid on them, and contained a little clay figure of a man carrying a golden scepter. The backs of the figures, which are similar to those found buried at the doors of other temples, bear inscriptions, which, however, are too much defaced to be legible. This temple contained three sanctuaries, which opened behind on a corridor by which the priests could reach any of the sanctuaries without being seen from the court in front. Under the four doors of this temple were buried inscribed clay cylinders, which aided us materially in our excavations, and in one of the chambers was found an unbroken building memorial cylinder of Nabopolassar, bearing an



NEW MAP OF KASR, NORTH AND SOUTH CITADELS OF ISTARTOR, EMACH TEMPLE, PROCESSIONAL AVENUE.

inscription of forty-one lines giving interesting and hitherto unknown details concerning the founding of the Chaldean empire and the personality of its founder. This inscription ranks in importance with various historical documents unearthed from the ruins of Babylon in the twenty years that preceded the commencement of the German excavations. These include the so-called proclamation of Cyrus, found in the Kasr by

the English explorer Rassam in 1879; the annals of the last Babylonian king, Nabunaid, acquired by the British Museum in the same year; and the list of Babylonian kings which forms the basis of the history of Babylon during 2,000 years. Any one of these documents outweighs in importance the twenty chapters of Herodotus which have led the world so far astray.

In passing it should be observed that the statement of Herodotus to the effect that Babylon was filled with buildings of three and four stories has caused many Assyriologists to doubt that Herodotus ever set foot in Babylon. It is practically certain that the Babylonian palaces had only one story, and the private houses in Assur, large numbers of which have been excavated by Andrae, reveal walls so thin that they could not have supported a second story. The hundreds of Babylonian leases of the periods of Nebuchadnezzar and the Persian dynasty which have come down to us do not contain the slightest allusion to upper stories. And buildings of three and four stories could not have vanished so completely as the private houses of Babylon have vanished.

As Nebuchadnezzar speaks of building the outer wall to protect Esagila "and the temples of Babylon," it is to be expected that other temples will be discovered. There is a hope, too, of finding at least the site of one of the great commercial houses like that of Egibi and Sons, whose "books," packed in great earthen vessels, were discovered by Arabs in 1874 in a quarter of the city in which Koldewey in 1901 found more than 400 inscribed clay tablets, of which some are of great value to philology and the history of religion.

We hope, especially, to find additional documents bearing on the history, civilization, and religion of the Babylonian people, and the wars of Nebuchadnezzar with Tyre, Jerusalem, and Egypt. If such documents are not discovered elsewhere, they will certainly be found in the great Esagila temple, the excavation of which is to crown our work in Babylon. This excavation will be a formidable task, for the ruins of the temple are buried to the depth of 75 feet. Xerxes destroyed the Babylonian temple, and Alexander the Great swept away its ruins, but beneath the new temple, which existed nearly to the Christian era, remained the foundations of the ancient "temple of heaven and earth," which comprised separate sanctuaries or chapels for all the principal deities and dwellings for the priests and priestesses attached to the temple of Marduk. There too remained, and still remains, the very ancient and imperishable temple archives, which Berossos, the Chaldean priest of Bel, employed in the compilation of his history of the Chaldeans, of which only fragments have come down to us. The exploration of Esagila, which has not yet been begun, will more than repay our whole expenditure of toil and money in Babylon.

ULTRA-FILTRATION.

A PROOF OF THE EXISTENCE OF MOLECULES.

BY DR. BECHHOLD.

The evidence for the molecular structure of matter is not exclusively chemical. The physical properties of gases are explained in the most satisfactory manner by the hypothesis that the gases consist of molecules moving in straight lines until they are depleted by impact with each other or the walls of the containing vessel. This, the kinetic theory of gases, has been extended by Van't Hoff to solutions.

A few years ago a chemist named Wald attempted

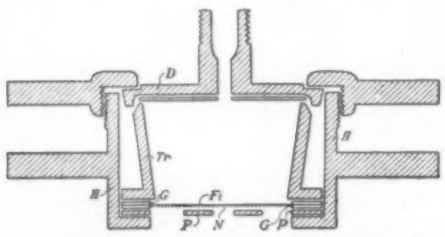


FIG. 1.—SECTION OF ULTRA-FILTER AND ITS MOUNTING.

F. Ultra-filter clamped between rubber rings *G G*. *Tr*. Funnel containing liquid. *D*. Cover fastened.

to show that, although the atomic theory is useful in chemical calculations, etc., it has no basis in fact and is at least superfluous. The substances that we actually perceive and know are gases, liquids, and solids, of various crystalline forms, fusing and boiling points, solubilities, etc., and Wald endeavored to prove that all chemical processes could be represented on the basis of these various conditions, or phases, without the aid of so bold a hypothesis as the atomic theory—with which, of course, the molecular theory is inseparably connected.

Recent investigations, however, have brought us very near the proof of the actual existence of molecules. If a lump of sugar is dissolved in water, the sugar becomes diffused through the entire volume of water, however large this may be. In regard to the state of the dissolved sugar, we can form no conception that can be tested by the evidence of the senses. Modern textbooks of physical chemistry designate solutions as "homogeneous mixtures" (Ostwald), "physical mixtures or physically and chemically homogeneous complexes" (Nernst), "homogeneous phases" (Ostwald). It is evident that everything depends on the meaning of the word "homogeneous," which Roozeboom defines as follows: "A system is called homogeneous when it possesses the same chemical composition and the same physical and chemical properties in all of its mechanically separable parts. Mixtures of gases or liquids appear homogeneous only because of the fineness of the molecules and the coarseness of our methods of observation."

To illustrate these definitions by an example, milk appeared to be a homogeneous mixture, and consequently a solution, before the invention of powerful microscopes; but now, when its oil globules can be distinguished with the microscope, we know that milk is not a solution, but a heterogeneous mixture. What the microscope has done for milk the ultra-microscope invented by Siedentopf and Zsigmondy in 1902 has done for those heterogeneous mixtures of much finer grain that are known as colloidal solutions. The smallest particles that can be distinguished with the microscope are about 1/5,000 millimeter, or 1/125,000 inch, in diameter; but with the ultra-microscope in concentrated sunlight it is possible to detect particles of a diameter of 1/200,000 millimeter, or 1/5,000,000 inch. These dimensions are little greater than those which are assigned, on theoretical grounds, to the largest molecules, for example, those of starch. If we could obtain stronger illumination than the sun furnishes in our latitude—if, for example, we could establish a laboratory on Mount Kilimandjiro in Africa and there concentrate huge sunbeams upon the field of the ultra-microscope—we could unquestionably see individual molecules.

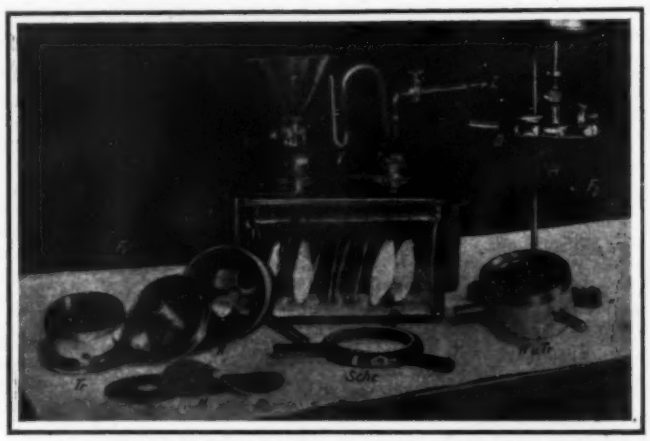


FIG. 3.—VACUUM APPARATUS FOR IMPREGNATING ULTRA-FILTERS WITH GELATINE.

L. Tube of air pump. *V*. Vacuum gage. *T*. Funnel containing jelly. *J*. Vacuum chamber with ultra-filters. At the right, stirrer *R* with driving wheel *Sch*. At the left and in front, ultra-filters and their accessories, lettered as in the diagram (Fig. 1).

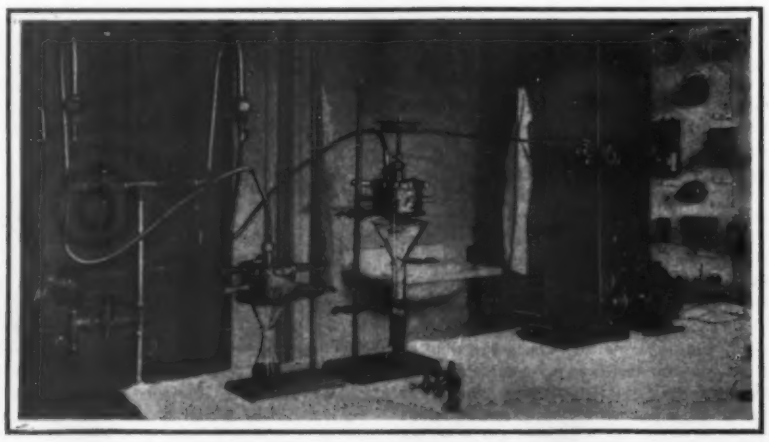


FIG. 2.—ULTRA-FILTRATION APPARATUS.

D. Compressed air pipe. *M*. Pressure gage. F_1, F_2. Ultra-filters. F_2 has a stirrer *R*, driven by the electric motor *E*.

Now, it is a very interesting fact that the minute particles revealed by the ultra-microscope are found to possess the very properties that are ascribed by the kinetic theory to the molecules of gases. In the year 1828 the English botanist Brown observed that very small lifeless particles in the field of the microscope possess a peculiar vibrating motion, quite different from the automatic movements of living microscopic organisms. The phenomenon is known as "Brown's motion." A colloidal solution of gold, when examined with the ultra-microscope, exhibits Brown's motion in an intensified degree. The minute particles of gold dart hither and thither, collide and rebound, presenting a wonderful spectacle. Observations with the ordinary microscope have proved that a certain degree of fineness is required for the production of Brown's movements, and that their velocity increases with the smallness of the particles. The ultra-microscope recognizes only luminous points, without form or size, but the dimensions of the particles can be inferred from their velocities, and Smedberg has discovered that the velocities of the smallest particles that can be detected with the ultra-microscope are of the same order of magnitude as the molecular velocities demanded by the kinetic theory of gases. Ehrenhaft has recently detected with the ultra-microscope movements of metallic dust diffused through gases which are quite similar to the movements of the particles of colloidal solutions.

These discoveries give a probability amounting almost to certainty to a bold hypothesis which was originally adopted merely as an aid to research.

The powers of the ultra-microscope are conditioned by the optical properties of the particles and the fluid in which they are suspended. Colloidal solutions of gold and silver are especially favorable objects for ultra-microscopic observation, while colloids which have a great affinity for water, such as silica, oxide of iron, albumen, gelatine, the ferments, and most other organic colloids, present considerable difficulty. Numerous points of light can be seen with the ultra-microscope in solutions of gelatine, but their numbers and intensity are much less than might be expected. The explanation is very simple. A large fragment of gelatine which has been soaked in water may be quite invisible when immersed in water because its index of refraction is about the same as that of water. Particles of gelatine may be invisible in the ultra-microscope for the same reason.

The writer has approached the problem by a different road, guided by the idea that it must be possible to separate dissolved substances from their solvents if sufficiently fine filters can be constructed. Turbidity is removed from liquids by filter paper, which has pores finer than the particles which cause the turbidity. The pores of the infusorial earth, burnt clay, and unglazed porcelain are much finer than those of paper, and cylinders formed of these substances extract bacteria from water forced through them under pressure. Of this character are the Berekfeld filter used in purifying drinking water and the Chamberland filter employed by bacteriologists in the preparation of germ-free liquids. Bacteria have diameters between 1/2,000 and 1/200 millimeter (1/50,000 and 1/5,000 inch) and nearly all species are retained by the Chamberland filter. As particles 1/33,000 millimeter (1/825,000 inch) pass through this filter, according to Zsigmondy, its pores must be larger than 1/33,000 millimeter and smaller than 1/200 millimeter. The writer has constructed filters with pores much smaller than this by impregnating paper and fabrics with gelatine in a vacuum apparatus. By varying the concentration of the jelly employed, it was possible to make a series of these ultra-filters of various degrees of fineness, with which coarser and finer particles could be removed separately from mixed solutions. It was also possible to ascertain the degree of fineness of some of the ultra-filters by applying them to solutions in which the size of the particles could be determined with the ultra-microscope. In this way, the maximum diameter of the pores of ultra-filters of medium fineness was found to be less than 1/50,000 millimeter (1/1,250,000 inch). These filters were just fine enough to extract hæmoglobin (the red coloring matter of the blood) and serum albumen from their solutions. Hence the dissolved particles of these substances must be smaller than 1/50,000 millimeter. I have recently measured the fineness of my ultra-filters by a method independent of the ultra-microscope, deducing the size of the pores from the pressure required to force air through them. With ultra-filters thus graduated it is possible to separate from solution, and determine the sizes of, particles invisible in the ultra-microscope because of their optical properties or their fineness, for some of my ultra-filters go far below the limit of the ultra-microscope. In this way the various disintegration products of albumen known as albuminoses can be separated from each other. Even dextrin, which may be called a crystalloid and has a molecular weight under 1,000, is retained in large part by the finest ultra-filters. The following table will give an idea of the magnitudes involved in these investigations:

	Diameter (or length). Millionths of a millimeter.	Millionths of an inch.
Human blood corpuscles...	7,500	300
Bacillus of splenic fever..	4,000—15,000	160—600
Cocci, or spherical bacteria	500— 1,000	20— 40
Limit of microscope.....	250	10
Wave length of red light..	690	27.6
Wave length of violet light	430	17.2
Wave length of ultra-violet rays	380	15.2
Albumen molecule	5— 10	0.2— 0.4
Limit of ultra-microscope.	5	0.2
Pores of finest ultra-filters.	1.5	0.06
Alcohol molecule	0.5	0.02
Hydrogen molecule (according to Pellat)	0.16	0.0064

The method of ultra-filtration carries us within the region of molecular dimensions. It enables us to separate from solutions particles smaller than the largest molecules and, in conjunction with the ultra-microscope, it has demonstrated, in my opinion, the actual existence of molecules.

But I doubt whether the particles of colloidal solutions accord precisely with the conceptions of molecules which we have derived from the behavior of gases and dilute solutions of crystalloids, like sugar and salt. Recent researches indicate that the conditions of concentrated solutions, particularly of substances of great molecular weight, are by no means simple. The molecules of the dissolved substance apparently form groups of various degrees of complexity with the molecules of the solvent. In certain colloidal solutions we have to do with such groups, and not with single molecules.

Ultra-filtration promises to be useful in medicine as a method of eliminating disease germs too small to be retained by the Chamberland filter or even to be visible with the microscope. Among these are the germs of smallpox, rabies, yellow fever, the foot and mouth disease of cattle, and the mosaic disease of the tobacco plant.

Dr. Ehrlich and I described last year several new germicides which have great power over the germs of numerous diseases. Some of these substances, added to cultures of diphtheria germs in bouillon in the proportion of 1 part to 500,000, arrested the development of the bacilli. They had the additional advantage of being little poisonous, so that animals could safely be treated with very large doses. Hence we were led to attempt germicidal experiments within the body by injecting the substances into the bodies of animals inoculated with diphtheria germs. No effect was produced, however, and we found that the germicidal action outside of the body was thirty-two times smaller on blood serum cultures than on bouillon cultures.

This great difference in effect might be due either to the greater vitality of the bacilli in blood or to the binding of most of the germicide by the albumen, globulin, and other solid constituents of the serum. In order to determine this point, I passed mixtures of the germicides with blood serum through an ultra-filter which retained the albumen, but was not fine enough to remove the germicide from its pure solution. Very little of the germicide passed through. This result indicates that only a small proportion of germicide injected into the living animal remains uncombined and active.—Umschau.

BEHAVIOR OF PLANTS TOWARD ALUMINIUM.

AN INVESTIGATION OF A NOVEL PROBLEM.

BY WOLF LA BAUME.

ALUMINIUM is scarcely mentioned in modern botanical literature, but if this element is absent from plants, with the exception of lycopodium and a few others, as the textbooks on physiological botany assert, how can this fact be reconciled with the general distribution of aluminium compounds in the soil? For it is well known that plants absorb from the soil elements which have no food value.

There are two possibilities. Either no aluminium compound in the soil is sufficiently soluble to be absorbed by the majority of plants—an improbable assumption—or the protoplasm of most plants is not permeable by aluminium. The latter possibility involves one of the most important problems of physiology—the problem of the permeability of protoplasm and its influence on assimilation.

This consideration induced Prof. Rothert, of the University of Odessa, to make the behavior of plants toward aluminium the subject of a prize competition among his students. The contestants were required: first, to determine from a special study of mineralogical literature whether the crust of the earth contains any aluminium compounds either soluble in water or so easily decomposed that they can be absorbed by plants; secondly, to collate all published statements of the occurrence of aluminium in plants; and thirdly, to determine by experiment whether plants assimilate aluminium offered to them in aqueous solution, and to observe the influence of aluminium salts on the life and growth of the plant.

The results obtained by two of the students, Borowikow and Schimkin, are given below.

In ordinary soils there is a continual formation of aluminium compounds which are available to plants as sources of aluminium. Such compounds, however, are produced only in small quantities. The kaolin which results from the disintegration of the primitive rocks and is the principal argillaceous constituent of soils is too stable a compound to supply plants with aluminium directly, although in contact with salts of the alkalies it gives off a small part of its aluminium in the form of unstable compounds, particularly aluminium phosphate, the decomposition of which by the roots of plants was experimentally demonstrated. The rocks, however, are not entirely converted into kaolin. Their decomposition gives rise also to small quantities of less stable compounds (hydrated aluminium silicates and oxides) which under the influence of salts of the alkalies or the mineral acids produced in the soil (nitric and sulphuric acids) may form aluminium compounds soluble in water and dilute acids. The production of such soluble compounds is also indicated by the normal occurrence of minute but appreciable quantities of aluminium in river and spring water.

The collation of the published analyses of plants gave little support to the theory that aluminium is of rare occurrence in vegetable tissues. A table compiled by Schimkin includes about 260 plants and parts of plants, the ash of which contained alumina in amounts large enough for quantitative determination, in addition to many cases in which only traces were found or only a qualitative determination was made. The proportion of alumina in the ash ranged from 1 to 5 per cent in about eighty cases, from 5 to 10 per cent in about 20 cases, and from 10 to 50 per cent in about twenty other plants, twelve of which were lycopodiums.

If these data are correct it follows that the presence of aluminium in plants is the rule, and its absence the exception. But this conclusion is unwarranted because the data are probably affected by errors of two sorts. The positive results may be attributable, wholly or in part, to clay adhering to the specimens analyzed, and, on the other hand, many of the negative results are doubtful because the specimens did not include the roots, in which most of the aluminium would be accumulated.

Hence it may be inferred that while the presence of aluminium in plants is by no means exceptional, the relative frequency and amount in which it occurs in various species can be determined only by new and thorough researches. It is certain, however, that alumina is an important or even the principal ingredient of the ash of some plants, including most of the lycopodiums. Thirty, 40, and even 80 per cent of alumina have been found in the ash of certain tree ferns. Smaller, though considerable, quantities are contained in many lichens and a few mosses and fungi. In these plants aluminium may perform some special function, the nature of which is difficult to determine by experiment as some of the plants cannot be obtained in sufficient numbers and others are not susceptible of cultivation.

The experiments on the penetration of soluble aluminium salts into living tissues and their effect on the plant gave the following results. Microchemical examination showed that all the plants which were investigated absorbed more or less aluminium when that element was presented to them in available forms—including not only soluble aluminium salts, but also aluminium phosphate and some other compounds insoluble in water. This result proves that protoplasm is *intrameable*, or can be penetrated, by aluminium.

The whole, or the greater part, of aluminium taken up by entire plants, however, was retained by the roots. It was proved, further, that soluble aluminium salts, even in very dilute solution, exert an injurious effect on plants, and especially on the growth of the roots. Yet the plants endured astonishingly large quantities of these same salts diffused through the earth, with the exception of the chloride, which had an injurious effect even under these conditions and when used in small amounts. In the absorption of aluminium from solutions the plant exerts an automatic regulation. Aluminium is absorbed up to a nearly constant limit, which is independent of the concentration of the solution and is apparently the same for all the salts employed.

The aluminium which has been absorbed is extracted by water with extreme slowness. In other words, the *extrameability* for aluminium appears to be much smaller than the *intrameability*.—Prometheus.

Impregnation of Casks.—Two parts of rosin and paraffin are mixed with 4 parts of benzine, to which 1 part of precipitated chalk is added.

THE FIGHT AGAINST EXTERMINATION.

WHAT HAS BECOME OF SOME WELL-KNOWN BIRDS.

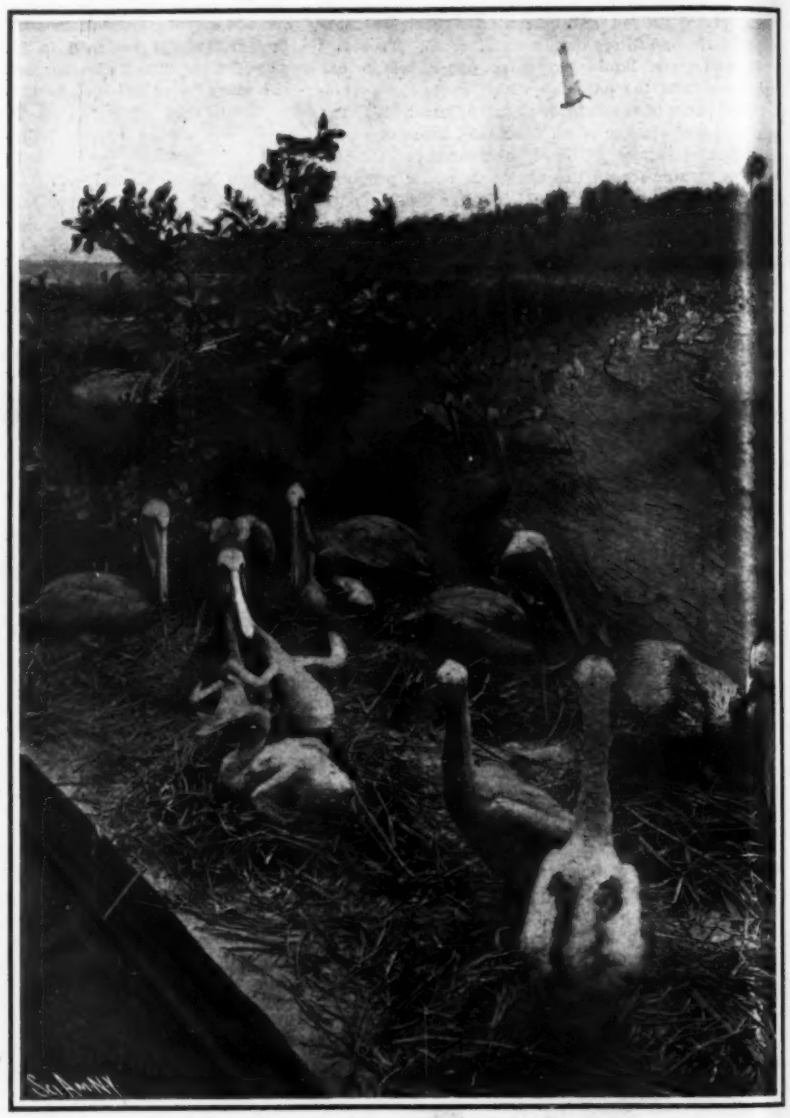
The great power which may be exerted by man in altering the balance of animal life finds an apt illustration in the fluctuations of some kinds of bird life. Fitted as they are for a fight against Nature, most animals possess some vulnerable spot, and if man happens to attack them in that spot the result may be fatal. People who are not yet old can remember flocks of passenger pigeons, which swarmed over oak trees in such numbers that the boughs of the trees sometimes gave way under their weight. And to-day a single specimen is of the rarest occurrence. Time and altered conditions may change this balance of things. In England, a thickly-populated country about the size of New York State, the wild pigeons are in some districts a pest to the farmers. If the few surviving passenger pigeons learn in their present seclusion to roam in pairs instead of in compact flocks, and develop a liking for grain—and birds sometimes transfer their preferences in food stuffs—they may again be common throughout the country. The passenger pigeon has so far avoided extinction, and there is hope for it.

Some birds, such as the eagle and the California vulture, decrease in numbers because they breed slowly—laying but one or two eggs at a time—and have the hand of the sportsman against them. Others may be introduced or exterminated locally by farming conditions. The irrigation of a tract of arid land drowns out the desert birds and introduces water birds; the reclaiming of a marsh wipes out the long-billed, long-legged birds of our swamps.

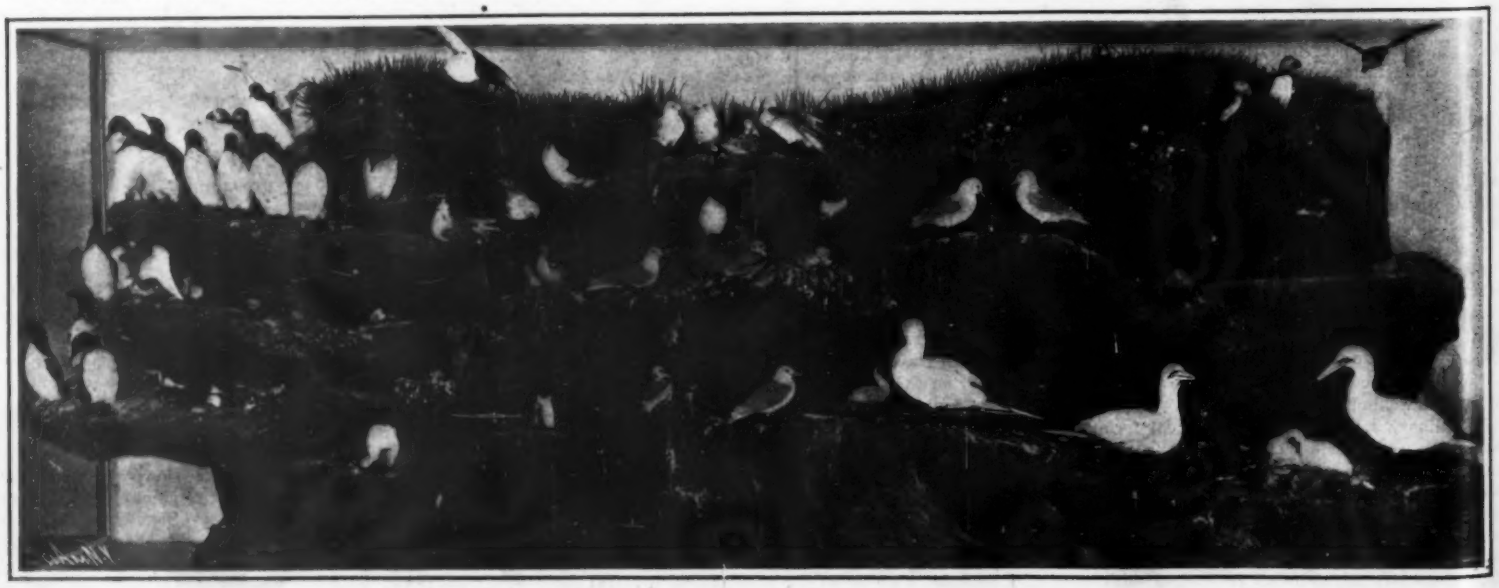
It has often been commented that bird life is more in evidence in England than in America, a thing which seems paradoxical, considering the respective sizes and populations of the countries. There are two main causes for this. In England birds are effectively protected during the breeding season; and over there

A GOOD EXAMPLE OF THE MOUNTING OF MARSH BIRDS.

WHAT CAN BE DONE IN THE WAY OF MOUNTING BIRDS NATURALLY.



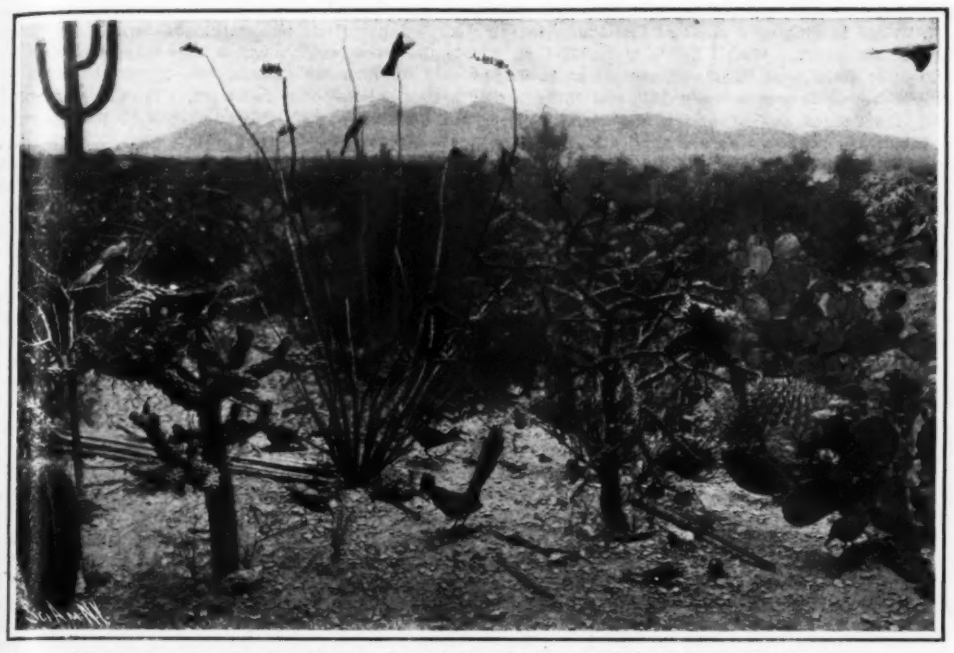
DENSELY-PACKED BIRDS IN A PELICAN HAUNT.



THE ROCKS OF THE ST. LAWRENCE. A GROUP OF SUB-ARCTIC SEA BIRDS AND THEIR EGGS.

barbed wire is little used. This last fact may need a little explaining; the fields are divided by hedges of thickly-grown bushes, and these form an effective shelter of innumerable small birds.

One of the most fatal habits of birds is community breeding. Flamingoes—shyest of birds—breed largely on some secluded mud flats in the Bahamas. A party



THE DRY SAND OF THE DESERT. BIRD LIFE AMONG THE CACTUS NEAR TUCSON, ARIZ.

of egg hunters, or even a slighter disturbance, will drive the birds to abandon their nests and eggs. When this affects a whole colony, it is a considerable limitation of the season's supply of young birds. Fortunately, the British governor of the Bahamas, acting on the suggestion of Prof. Chapman, secured the passing of a law protecting these birds during the nesting season. The illustration which we publish of a pelican haunt well shows this weak point. A party of hunters, or even a few mischievous boys, could work great havoc among such closely-packed birds and nests.

Among the most graceful of birds are the terns or sea swallows. Light and swift on the wing, they are not the easiest of marks for a gunner, and yet some species have been exterminated, it is believed. Commerce has had a hand in this; the graceful birds have been considered a fitting adornment for ladies' hats, and so the terns have been slaughtered. They breed on well-known spots on sandy shores, and here the hunters search them out at a time when their eggs or young should bring them immunity.

The heavy-flying sub-arctic birds, such as murres and razor-bills, have suffered severely, and very wantonly. They perch on cliff ledges in compact masses and show little fear of man; consequently, they have proved an attraction to that class of hunter with no ambition beyond record slaughter. The graceful kittiwakes, that breed on the same rocks, fall victims to the fashion that has proved so fatal to the terns.

In some ways the birds of the desert, where man cannot hunt except with personal discomfort, have the advantage over their cousins of the shore.

It is fortunate that interest in things natural has been developed before it is too late. Some redwoods survive in California, immune from the axes of the lumbermen. The bison is not absolutely extinct, and will be kept alive. Even in Central Africa the British government has stepped in, and the large game there will be saved from actual extermination. Where buffaloes and giraffe survive, it seems to be assured that our bird life will continue with us.

The illustrations are supplied by the courtesy of the American Museum of Natural History, New York.

ANCIENT ASSOCIATION OF THE RAT WITH PLAGUE EPIDEMICS.

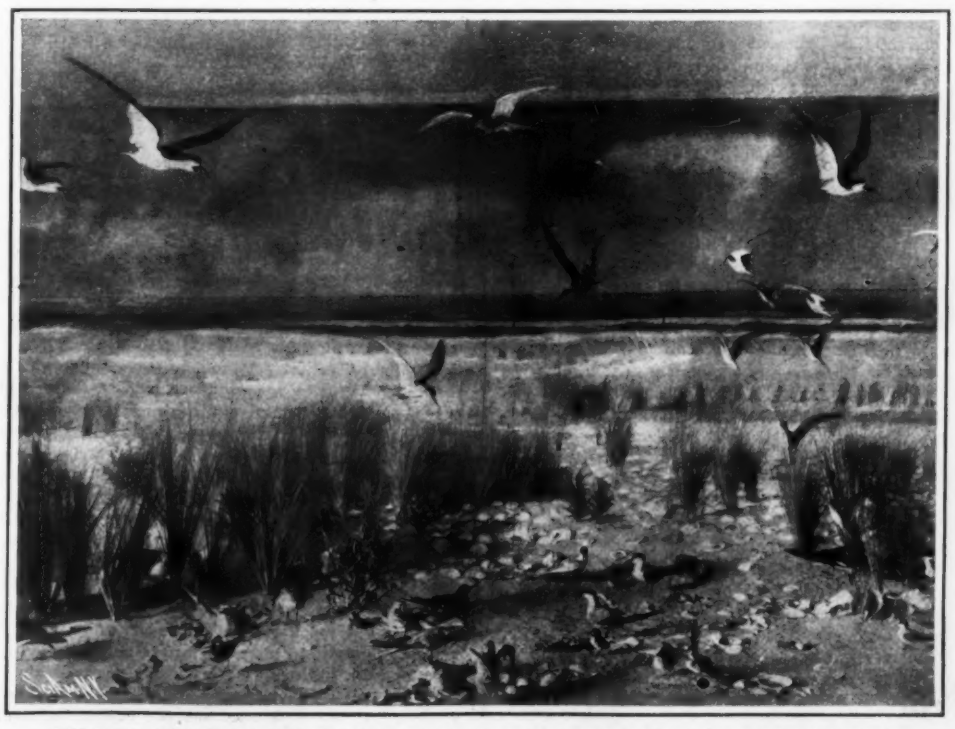
THE association between plague and rats is a very old observation. Apart from scriptural references there is evidence derived from some of the ancient monuments and coins of the connection being known. Apollo and Æsculapius are each represented with the rat at their feet. There was the famous statue of Apollo by Skopias in which the god has a rat at his feet. Snakes are destroyers of rats, and in Asia Minor and elsewhere before the advent of the cat harmless snakes were kept in houses and in the temples doubtless for that purpose. This practice probably explains the accounts so frequently given of snakes and serpents dying during epidemics of plague. Both the cat and the snake were venerated for their services to man.

There is an interesting coin brought to my notice by Dr. Sambon and which can be seen in the collection of colonial Roman coins in the British Museum. It is a coin of the Emperor Lucius Verus struck at Pergamum in Asia Minor during a plague epidemic and represents Æsculapius with a rat at his feet and a small human figure standing by with his arms outstretched in the attitude of fear or worship. In the same collection there is a medallion of the Emperor Antonius struck in commemoration of the erection of a temple to Æsculapius on the Tiberine Island at Rome. Plague was epidemic in Rome and a mission was sent to the temple of Æsculapius at Epidaurus to ask for advice. The advice given by the Æsculapian priests was apparently to destroy the rats, for on the reverse side of the coin is the return of the mission with a serpent, being welcomed by the river god.

The dissemination of plague by domestic animals was formerly recognized even more than it is at the present day and very decided views were held, particularly regarding those animals in close association with man; not only rats but also dogs, fowls, and pigs were held to be agents in spreading the disease. When plague prevailed in Europe these animals were as much inmates of the house as the people themselves and it was observed, as it is in southwestern China to-day where the same conditions prevail, that during epidemics of plague the rats, fowls, pigs, and cattle sickened or died, which was attributed to plague. In the pandemic of 1348 it is recorded by numerous observers that dogs, cats, fowl, cattle, and rats died from the disease. Skeyne in 1568, in his work on the pest, states that "quhan the domestical foules become pestilential it is ane sign of maist dangerous pest to follow." The observations became so general that they formed a basis for certain orders in regard to the suppression of plague. Every European country has in its old orders concerning the checking of plague epidemics instructions to the inhabitants under certain penalties to kill domestic animals or to keep them confined to the house. Creighton mentions some of these orders as bearing on the regulations in England and Scotland against the spread of plague.

In the regulations in London against the plague in the seventeenth century it is ordered that no hogs, dogs, pigeons, or conies shall be suffered to be kept within any part of the city. In Rouen on April 14, 1407, it was ordered under penalty that no person of any condition or rank should keep pigs. When plague broke out again in 1498 a similar order was issued, and in 1566 the priests of the Madeleine and commander of St. Antoine were forbidden to keep in their houses pigs, fowls, and rabbits. At Evereux in Normandy a police order was issued in 1561 that every one of whatever quality of rank should not keep pigeons, fowls, rabbits, and pigs under penalty of confiscation and a fine of ten livres, and anyone giving information would receive half the fine. The killing of dogs is in nearly every order. A photograph, kindly lent to me by Mr. Henry Wellcome, of a painting in the archives of Bologna representing a plague epidemic in that town is interesting, as it illustrates the actual killing of dogs during the epidemic. The picture shows the magistrate and his officers on duty. Some of them are removing the dead, who are being lowered from the windows of the infected houses; priests are also to be seen administering the Sacrament. In the foreground are some men killing a dog and a little farther back is a dog transfixed with an arrow. Similar measures for controlling plague were taken at Palermo in 1575. Ingrassia says, "an excellent measure was proposed and carried out. All dogs, cats, and other animals that might convey the plague from one house to another were to be destroyed." Not only were the dogs of the town destroyed but all those within a radius of at least four miles. Fiochetto, describing the measures that should be taken in the event of the discovery of an infected person in any house, says "fifthly, having killed all cats, dogs, fowls, and pigeons, prepare arsenic for the rats." No mention is made of fleas on these animals but it is evident that experience had taught the authorities that these animals sometimes by contracting the disease and sometimes by carrying the infection on their coats, fur, and feathers, though not infected themselves, conveyed plague. In connection with the conveyance of the infection by animals not suffering from the disease there is the observation made by the Austrian Commission in 1897 of plague bacilli appearing in the fæces of a dog fed with plague material.—Prof. W. J. R. Simpson in a paper on "Plague," read before the Royal College of Physicians, London.

To Make Durable Wooden Taps.—The wood is impregnated by immersing it for 5 minutes in melted paraffine, heated to 302 deg. to 320 deg. F., and then allowing it to drain off. By this means all the pores of the wood will be filled with paraffine, preventing the penetration of moisture, which causes the splitting and shrinking of the wood.—Bersch.



THE DRY SAND OF THE BEACH. A NESTING PLACE OF TERNS OR SEA SWALLOWS ON COBB'S ISLAND, VIRGINIA.

THE FIGHT AGAINST EXTERMINATION.

Correspondence.

WHO INVENTED THE SHIELD AND COMPRESSED-AIR METHOD OF TUNNELING?

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

The interesting article in your SUPPLEMENT of February 15 by your Paris correspondent, describing the construction of the subways in that city, makes the somewhat surprising statement that "the tubes were run under t e River Seine by the American shield and compressed-air method; a method of engineering apparently less known in France than in this country"—a statement more commendable for its patriotism in claiming that method as American than for its accuracy.

The remarks quoted appear in the titles of your excellent illustrations and may, therefore, be due to local sub-editing, since they are unsupported in the letterpress of the author of the article, and, indeed, they could hardly be attributed to anyone resident for any length of time in France and with the knowledge of engineering matters displayed by your correspondent. In view, however, of the prominence given to the above remarks and your reputation for accuracy, you will perhaps be willing to give me the courtesy of a brief space in your columns for a few historical data throwing light upon the claim of America to the compressed-air and shield method of tunneling.

To take them in their chronological order, the principal events in the history of the tunnel shield and the application of compressed air to work in water-bearing strata, irrespective of their combined use, are as follows:

In 1818 the first recorded patents for a tunnel shield were granted in England to Mark Isambard Brunel, who commenced his Thames tunnel in 1825, completing it in 1842. In 1830, patents were first granted to Sir Thomas Cochrane in England for a method of constructing shafts and tunnels in water-bearing strata by means of compressed air, applying to inland work the principle of the diving-bell described by Dr. Halley in 1721 and used by Smeaton in England in 1778. Both these patents are singularly comprehensive, especially that of Brunel, and, great as have been the modifications in design of later American and other shields and compressed-air devices, it may safely be said that there is no essential feature in the latest shield and compressed-air tunnel practice which is not included in principle in their specifications.

Cochrane's method was first used in France in 1839 by M. Triger in sinking a shaft at Chalonnes, in the valley of the Loire. Works below water-level on a considerable scale were built at three places in England and five in France between 1840 and 1868, principally the foundations of bridge abutments, before the system had its first recorded application in America in the foundation caissons of the St. Louis bridge over the Mississippi River, Dr. Jaminet (a Frenchman at least by extraction) having charge of the personnel.

The first application of compressed air to horizontal tunneling was made simultaneously by Mr. Haskin in New York and M. Hersent in Antwerp in 1879. The undertaking of the former was certainly immensely greater; but whereas M. Hersent was successful, with all honor to Mr. Haskin for his intrepidity and perseverance and the value of the experience gained, his work failed altogether.

To return to the shield, the first American patents were granted in 1868 to Mr. Beach for a shield more resembling that of Barlow patented in England in 1864 than that of Brunel. Mr. Beach's shield was used in the Broadway subway in 1869 (simultaneously with the construction of the Tower subway under the Thames in London, with a shield of the Barlow pattern), and later in Cincinnati and Cleveland, but a shield identical in principle had been patented by M. Guibal in France in 1857, for vertical work.

In 1886 compressed air was first used in conjunction with a shield in the City and South London Railway by Mr. Greathead, whose method was adopted in the Mersey Tunnel in 1888, the Glasgow Harbor Tunnel and Subways, the Blackwall Tunnel, and the Siphon de Clichy in Paris among others, before its first successful use in a completed tunnel in America. This was by an Englishman, Mr. C. M. Jacobs, engineer of the recently opened Hudson Companies' tunnels, who successfully completed the East River gas tunnel in 1894 with shield and compressed air after unexpected difficulties had caused failure by other methods.

It should be remarked, however, that in 1899, an English company resumed work on the long-neglected Hudson Tunnel, their work with shield and compressed air being entirely successful and largely contributing to the recent consummation, and suspended operations only for financial reasons.

It will be seen, therefore, that the use of the shield in America was anticipated abroad by fifty years, the use of compressed air by nearly forty, and their combined use in successfully completed work by some eight years. In addition to this, French engineers had constructed several of the principal sewer tunnels of Paris and part of the subway by the shield and compressed-air method before the recent successes in America in larger and possibly more difficult work. Among the former, some of the work on the Collecteur de Clichy, executed by means of the Chagnaud shield at a depth of less than a yard in places below the uninterrupted heavy traffic of a busy street, forms one of the most remarkable achievements in the history of shield tunnelling, so that it seems a little unfair to French engineers to be told in your always generous and generally most accurate pages that they have "adopted" the American method of tunneling.

Reference to the dates of the City and South Railway (1886), the Waterloo and City Railway (1893), and the Baker Street and Waterloo Railway, London (1898), all passing under the Thames; the Spree Tunnel in Berlin (1895), and the Paris Extension of the Orleans Railway (1898), makes most surprising of all your statement (under the lower illustration) that "this is the first time a European railway tunnel has been driven under a river by the American compressed-air method."

Yours truly,

ERNEST JOHN MUNBY.

Carl Junction, Mo., February 25, 1908.

WAR BALLOONS.*

THE MILITARY USE OF CAPTIVE, FREE, AND DIRIGIBLE BALLOONS.

BY AUGUSTE E. GAUDRON.

BALLOONS for war can be classed under three heads: The captive balloon, the free balloon, and the dirigible balloon.

The captive balloon has been in use by various powers for a long time, and it has been practically developed to its limit. The balloons may differ in shape and in the materials of which they are constructed. The captive balloon is used to discover the strength and disposition of the enemy on land or sea. The free balloon has a much larger field of action, and it certainly has not been fully developed.

Great things will be done in peace and war with war balloons. For example, it would not be difficult to send up one hundred balloons in one day, from London to the Continent, carrying a total of 5,000 men. The cost of such undertaking would not be great, say about $300,000. What would be the good of sending 5,000 men to the Continent? But I merely mention this as an example. I point out what could be done. The 5,000 men could be reduced to 300, say 100 aeronauts, one to each balloon, and 200 officers, two to each balloon, and the remaining lifting power could be taken up with ammunition.

Certainly three or four balloon manufacturers could manufacture the 100 balloons in three months. There is ample coal gas in London to fill all these balloons in one day, and the only difficulty would be to find 100 practical aeronauts to take charge of the aerostats and make the best use of them. But, again, see what was done during the siege of Paris in 1870 and 1871. Sixty-five balloons were constructed, and out of the sixty-five aeronauts only about five had been up before. Some of the ascents took place at night, and only two aeronauts were lost and five made prisoners by the Germans.

The sixty-five balloons carried 164 passengers, some 25,000 pounds of postal material, representing about 2,500,000 letters; 381 carrier pigeons were also taken up, and did good service by carrying nearly 100,000 messages and telegrams. The receipts from letters and telegrams were nearly $200,000, and the expenditure for the manufacturing of sixty-five new balloons and the pay of the aeronauts amounted to about $58,500, including the necessary gas, so that there was a margin of $141,500 of profit.

These facts show that balloons are not merely an expensive hobby, but that good use can be made of them. With regard to the distance a balloon may travel, I may here say that in my journey to Sweden from London we had one ton of ballast, and only used about 30 pounds, and we traveled 703 miles in nineteen hours. I leave it to you to work out what it would have cost to carry one ton of goods and three passengers from London to Brackan, in Sweden, in nineteen hours.

And now, what are the present position and future prospects of the dirigible balloon? A certain German professor once declared that no balloon could ever be made whose fabric and framework could withstand a wind of 20 miles an hour. This reminds me of a story I was told of a great mathematician, Prof. Tait, who demonstrated that it was scientifically impossible for a man to drive a golf ball more than 180 yards. The next morning Prof. Tait's son drove a golf ball 220 yards. And with regard to the very crushing theory of the professor, I would remark that no balloon has ever collapsed purely through the force of air—while in the air. As a matter of fact, it is simply a question of keeping your gas bag well filled, and properly made and attached. Some day it will be a question of making the gas bag stronger than existing bags.

With a dirigible balloon, it is possible to take up a motor that will work well, and also to carry fuel for the motor. The nearest problem to that presented by the dirigible balloon is that solved by the familiar barge, but instead of tons, the airship can carry only pounds. That is the difficulty, and it is only in recent years that progress has been made in solving it.

If you want to steer a balloon through the air you must modify its form to give less resistance; in passing through the air you must reduce friction to a minimum; you must find a strong, light envelope capable of retaining the hydrogen gas for a certain time; you must do away with all superfluous netting, and you must procure a reliable and powerful motor, a propeller or propellers, and a rudder. Above all, you must put good workmanship into it and get plenty of practice with it. Before you master your airship you must first be its slave, and your labor is bound to be rewarded if you persevere, but you cannot become an expert without hard work.

On the Continent great progress has been made. The Lebaudy airship is certainly the best ever produced. It has probably made more than 300 voyages. I mean by a voyage leaving its station and returning to it, after having made a journey of ten to sixty miles. Its longest journey was, I believe, 170 miles, and when we reckon that the only accidents which happened to it were on the ground, when the men could not hold it against the wind, whereas a few minutes before it was up in the air steering in all directions, and proving its capability of gliding through a fairly strong wind, it will be conceded, I think, that the Lebaudy airship is a thing to be reckoned with. What could the Lebaudy airship do in war? It has carried as many as seven passengers, but an airship should not be expected to carry so many. As much margin as possible should be left for ballast and motor fuel, also for ammunition.

The airship will certainly play a great part in future European wars. The construction of one hundred airships would cost less than a first-class battleship, but I believe they could be relied upon to do far more damage. The fact that the dirigible balloon has its limitations should not blind us to its capacity. Even the "Dreadnought" has limitations. I am afraid much error is spread by popular sensationalism in newspapers and magazines which lead people to suppose that the conquest of the air is an accomplished fact, and that France and Germany have each a fleet of equipped and manned airships, and that each vessel can easily drop a few hundredweight of shells on battleship or fortress!

Of course, the capacity to carry and discharge explosives is strictly limited. As you lessen the amount of weight carried by the balloons you cannot take in fresh ballast while in the air, any more than you can renew your supply of gas. Yet even with these limitations, the dirigible balloon is a war instrument of great potentiality.

It is no easy matter to drop shells onto a small target from a height of 3,000 or 4,000 feet, yet it is necessary to keep at such altitudes in order to be out of range of the enemy's guns. Probably this difficulty will be solved very simply by lowering the ammunition to the end of a long wire hanging perhaps two or three thousand feet below the balloon, and releasing it by electric current when immediately over the desired point. Imagine the destruction that would be caused by a 100-pound shell of dynamite falling on a battleship.

* Journal of the Society of Arts.

THE OXY-ACETYLENE BLOWPIPE.*

A NEW METALLURGICAL INSTRUMENT.

BY CECIL LIGHTFOOT.

THE oxy-acetylene welding process affords to engineers and others the most practical and valuable method yet discovered of dealing simply and economically with an immense variety of metallurgical operations which have hitherto been carried out under less favorable conditions. The oxy-hydrogen blowpipe and the process of electrical welding are still of very great service in many instances but something more was wanted. The intense heat generated by the oxy-acetylene flame has been well known for years and indicated the direction in which to look for what was required, but experimenters were for long baffled in their researches by the want of a suitable form of blowpipe in which to utilize these gases to the best advantage. The credit of having developed this latest method of welding is chiefly due to a French engineer named Fouche, who, after a long period of experimenting, ultimately constructed a blowpipe on the well-known injector principle and from that time the process was placed on a sound basis. The rapidity with which the Fouche oxy-acetylene blowpipe has been taken up by engineers is the most striking testimony as to its merits.

In many cases where electric welding has hitherto been the only possible substitute for mechanical joints the blowpipe can be more profitably employed and in a large variety of work the blowpipe can be used when electric welding is impractical. In actual use it is both cheaper and simpler than electric welding and whereas a blowpipe weld can be effected without altering the character of the metal an electric weld tends to injure the metal and render it brittle where joined, so that the results obtained are somewhat uncertain.

An electric welding installation necessitates considerable capital outlay and the cost is high. On the other hand, the cost of a blowpipe equipment is comparatively low in proportion to the scale on which it is employed. One of the principal advantages of the blowpipe system of welding metals by simple fusion is that as the heat can be applied locally, the various parts of complicated structures can be fitted together and welded in position.

As is well known, acetylene is an endothermic gas made up of hydrogen and carbon. In a properly regulated blowpipe the acetylene splits up into its constituents at the base of the flame, only the constituent carbon taking part in the combustion, owing to the fact that hydrogen will not combine with oxygen at the high temperature produced when carbon burns in oxygen. The hydrogen consequently remains free and forms a protection to the small cone at the nozzle of the blowpipe where the carbon is burning, and which is the point of maximum temperature.

By means of the oxy-acetylene blowpipe a temperature as high as over 7,000 deg. F. has been obtained as compared with 3,600 deg. to 4,500 deg. F. in the case of the oxy-hydrogen flame. Furthermore, one cubic foot of acetylene will develop about 1,600 B. T. U. while a cubic foot of hydrogen will only develop about 340 B. T. U. The heat developed in the oxy-acetylene flame, besides being almost twice as intense, is, therefore, nearly five times as great as in the oxy-hydrogen flame. The temperature of the oxy-hydrogen flame is limited to the dissociation temperature of steam, whereas in the oxy-acetylene blowpipe the temperature is only limited by the dissociation temperature of carbon monoxide.

Theoretically in order to insure the complete combustion of acetylene 2.5 volumes of oxygen are required for each volume of acetylene. In practice, however, it is found that the proportions vary from 1.5 to 1.8 of oxygen to 1 of acetylene, according to the purity of the oxygen used. It is also interesting to note that the oxy-acetylene blowpipe flame possesses the remarkable property that it may be rendered oxidizing, neutral, or reducing at will.

There are at the present day two types of oxy-acetylene blowpipes in use. Although there is practically no difference in the character of the work executed by these types, the principle of working is entirely different in each case. These two types of blowpipe may be best described as:

a. The high-pressure mixed jet.

b. The injector jet or low-pressure blowpipe.

With regard to the former and earlier of these two types in the high-pressure mixed-jet type of blowpipe the supply of both oxygen and acetylene are under pressure. This blowpipe was primarily constructed for working with dissolved acetylene and is thus not adapted for use in direct connection with an acetylene generator. Furthermore, it has been found that with the high-pressure blowpipe, as is only to be anticipated, considerably more acetylene is required to perform a fixed quantity of work than is necessary with a low-pressure blowpipe. The difference in the quantity of gas consumed in addition to the difference in price between dissolved acetylene and acetylene supplied from a generator greatly increases the cost of operation of this type of blowpipe compared with the low-pressure type, especially when it is considered that with an increase in the quantity of acetylene used there is a proportional increase in the amount of oxygen required.

The injector jet or low-pressure blowpipe (Fouche's patent) is supplied solely by the Linde Air Products Company, Buffalo, and is very carefully designed and proportioned to meet all the special conditions with which an oxy-acetylene blowpipe must comply. It is perfectly safe for use, being so constructed that the flame cannot strike back. The gases are well mixed in the injector chamber before they issue from the nozzle of the blowpipe and the nozzle itself is so formed that the possibility of carbonaceous deposit in the orifice is practically obviated.

This blowpipe is made in ten different sizes and the following table gives the approximate thickness of iron or steel plates for the welding of which each size is best adapted, together with the approximate quantities of each gas consumed per hour. Each size is accurately and carefully adjusted and in this way it is possible to select the exact size of blowpipe most suitable for any particular class of work.

Blowpipe No.	Approximate Thickness of Sheet or Plate, Inches.	Oxygen Consumption Cubic Feet per Hour.	Acetylene Consumption Cubic Feet per Hour.
2	1/32	3	1¾
3	3/64	4¼	2½
4	3/32	7½	4½
5	⅛	12	7
6	3/16	17	10
7	¼	25	15
8	⅜	37	22
10	½	60	35
12	⅝	85	50
15	¾	125	75

With the low-pressure type of blowpipe a much more intimate mixing of the two gases is obtained than in the high-pressure type, and thus high efficiency is secured. Furthermore, the adjustment of the flame is much simpler when only the oxygen is under pressure. Once the flame is correctly adjusted it remains so, whereas with the other system, in which both gases are delivered to the blowpipe under pressure, constant manipulation of the flame is necessary.

For the reasons given above the high-pressure mixed-jet type of blowpipe is being rapidly superseded and replaced by the more modern and efficient low-pressure blowpipe in cases where economy of work and cost of operation are considered. It cannot be denied, however, that a high-pressure blowpipe is distinctly useful in a limited sense, especially for effecting repairs. While it would be impractical to transport an acetylene generator from place to place, a small cylinder of dissolved acetylene is easily handled. On the other hand, it should be borne in mind that the low-pressure blowpipe can also be quite well and economically employed with dissolved acetylene.

Carbide at market prices can be obtained from depots which are situated in the principal towns in the United States. In this way the low-pressure blowpipe offers an additional advantage over the high-pressure type in that the cost and delays of the transportation of dissolved acetylene are obviated.

As regards the cost of the oxy-acetylene welding process, much depends on the nature of the work and the capacity and skill of the workman, but it may be stated generally that the system compares very favorably with the cost of riveting or brazing. It is not claimed that the process will entirely supersede ordinary forge welding or even electric welding under certain conditions, but the blowpipe is such a clean, convenient, and portable tool that it enables a large variety of different and complicated welding to be done *in situ* where riveting or brazing of joints would otherwise be necessary. It, therefore, greatly extends the scope of welding.

It is impossible to enumerate in detail all the work which may rapidly and economically be executed by this blowpipe, but some of the applications for which it has already been advantageously employed are given below

The welding in place of brazing of bicycle frames forks, T standards, wheel rims, etc.

Welding of frames, wheel rims, etc., for motor cars.

In the manufacture of iron or steel motor and other boats as a substitute for riveting.

The welding of hot water boilers.

The repair of steam boilers and other apparatus *in situ*.

The welding of steel and iron tanks.

The manufacture of safes.

The fusion joining of pipes of every description and shape for steam superheaters, etc.

The welding of all joints in metallic casks, petroleum barrels, etc.

As a substitute for riveting thin sheet iron work, such as enamel ware.

Artistic iron work.

Repairs to castings and forgings of iron and steel, such as are necessitated by cracks, blisters, blowholes, bad welds, etc., as well as by errors in construction.

As a substitute for brazing in copper work of various descriptions. By means of the oxy-acetylene blowpipe copper pipes and many kinds of sheet copper structures can be welded together as one pipe or piece where brazing would otherwise be necessary.

For the repair of articles of aluminium, particularly such pieces as gear cases and automobile accessories generally, the oxy-acetylene blowpipe is invaluable.

As an example of the quality of the work, it may be stated that plates of iron and steel in thickness from 20 gage upward when welded together by the blowpipe have proved stronger at the joint than in the body of the plate. Continued tests of bars of iron fused together by this system have given an ultimate strength of over twenty-nine tons per square inch at the joint.

The speed at which blowpipe welding can be done varies to a considerable extent with the character of the job, the capacity of the workman and his skill in handling the blowpipe. It may, however, be stated that any ordinary workman of average intelligence very quickly becomes proficient in the application of this method of welding. A general idea of the rate at which work of this nature can be done may be gathered from the following table, in which the approximate foot run of welding per hour is given for various thicknesses of iron sheets and various corresponding sizes of low-pressure blowpipes. The quantities of gas consumed per hour by each of these blowpipes are given in the previous table, so that the approximate cost of welding per foot run may be readily estimated:

No. of Blowpipe.	Thickness of Plate, Inches.	Foot Run per Hour.
3	3/64	35
5	⅛	20
8	⅜	10
10	½	6

The above figures are average results obtained when working on cold plates. By previously heating the piece to be welded in the neighborhood of the joint, the time and cost of making the weld may be reduced from 30 to 50 per cent in the case of plates of one-quarter inch thickness and upward.

The injector blowpipe does not necessitate the use of any particular form of acetylene apparatus and any existing well-designed generator may be employed. In the selection and arrangement of the apparatus, however, the following points should be more especially observed:

1. The generator must be of ample capacity for the continuous production, without heating, of the maximum quantity of acetylene required.

2. Whether the system employed be automatic or non-automatic, the holder must be of sufficient capacity to obviate any loss of gas due to production when the supply to the blowpipe is shut off.

3. The apparatus must be so constructed that there is no appreciable admission of air to the generator when recharging with carbide.

4. The limit of pressure in any part of the apparatus should not exceed 20 inches of water.

5. The size of the pipe conveying the gas should be proportioned to the maximum rate of generation.

6. The apparatus should be so constructed that it is impossible to hermetically seal the generator.

7. The apparatus adopted should be of a type which has been examined and passed by the National Board of Fire Underwriters.

* Paper read before the International Acetylene Association.

TYPES OF RECENT FOREIGN FLYING MACHINES.

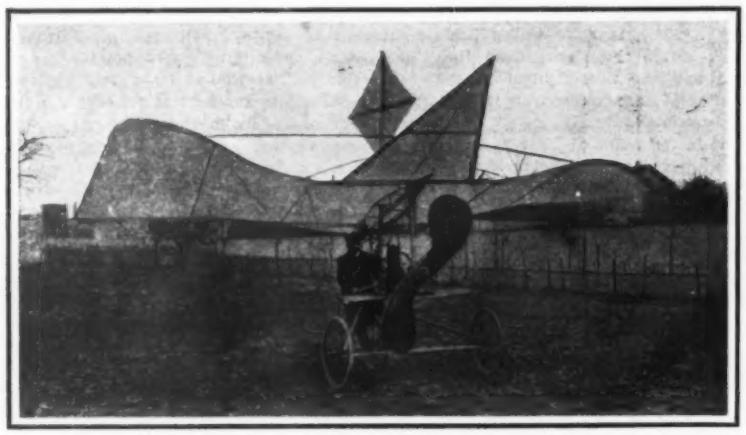
SOME FRENCH AND DANISH AVIATION APPARATUS ALREADY BUILT OR BUILDING.

AMONG the novelties in the line of heavier-than-air flying machines now building in France are the Bertin helicopter, or screw propeller machine, and the Collomb ornithopter, or flapping-wing machine, both of which are illustrated herewith.

THE BERTIN HELICOPTER.

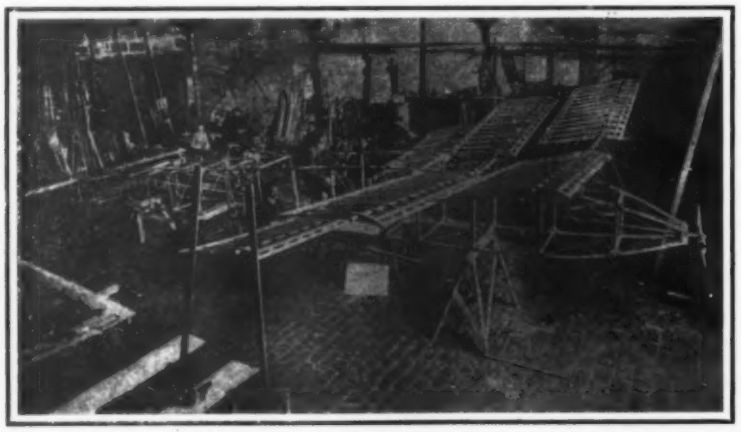
The two photographs of the Bertin helicopter show very well the general arrangement of the engine and propeller shafts, although the propellers are not visible. The engine is of the opposed-cylinder air-cooled type, having eight cylinders of 115 millimeters (4.527 inches) bore by 155 millimeters (6.102 inches) stroke. A separate camshaft for each four cylinders operates the exhaust valves, while there are also auxiliary exhaust ports near the base of each cylinder. The inlet valves are automatic. A separate carbureter is fitted to each set of cylinders. There is also a special starting crank, which is not thought necessary with most of the other 8-cylinder motors, as a simple twist of the propeller, when this latter is mounted on the engine crankshaft, usually suffices. Since this is not the case in the present instance, a starting crank is necessary. As can be seen in the photograph, a short shaft projecting out from each end of the engine crankshaft drives a vertical shaft through bevel gears. These shafts all run on ball bearings. On top of the vertical shafts are the two lifting screws, which turn in opposite directions. There is also a third vertical propeller driven through gears and a universally-jointed shaft from the motor crankshaft and this serves for forward motion and for steering, since it can be moved at an angle of 30 degrees to each side. A horizontal rudder is not needed on this machine, as by speeding up or slowing down the main lifting screws, the apparatus can be made to rise or fall. Should the engine stop while the helicopter is sailing through space, it will, of course, come to earth; but its fall will be lessened in violence, owing to the momentum of the propellers. As the machine can rise vertically, there is no need for wheels such as are used in all aeroplanes for running along on the ground.

The lifting screws of the Bertin helicopter are 2.8 meters (9.18 feet) in diameter. They are geared to the motor crankshaft in the ratio of 1 to 2, and make 1,250 R. P. M. The vertical propeller makes the same number of revolutions as the motor crankshaft. All three propellers are of the two-bladed type, as these are found to give the best efficiency. This machine is capable of carrying two people, one of whom is intended to sit in front of the motor and steer, while the other sits behind the motor and operates it. The total weight of the complete machine is only about 310 kilogrammes (683 pounds), while the weight of the motor itself is but 120 kilogrammes (264½ pounds), or about 1 kilogramme per horse-power if the motor comes anywhere near its rated capacity of 150 horse-power, which is extremely doubtful. The inventor believes that by placing the horizontal engine below the propellers, the downward stream of air from these will cool it thoroughly. The use of auxiliary exhaust ports is also depended upon to aid in keeping the motor cool. In the first test made recently, this machine rose to a height of about 10 feet and lifted two people. As soon as the weather permits, it is expected to test it more thoroughly in the open.



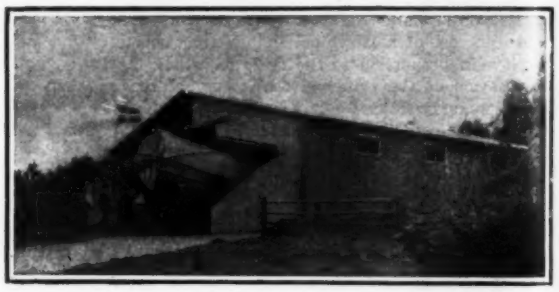
THE GILBERT AEROPLANE—A RECENT FRENCH MACHINE.

Note the downward curve of the wings near their ends, the diamond-shaped and triangular vertical and horizontal rudders, and the peculiar S-shaped propeller used.

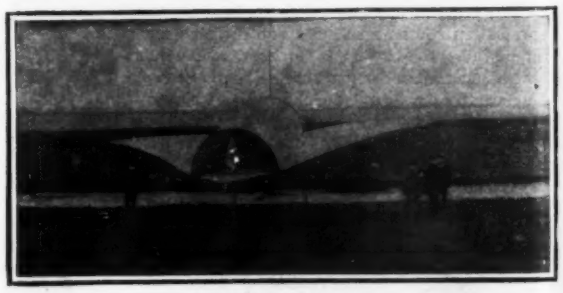


BODY FRAMEWORK OF NEW FARMAN AEROPLANE, SHOWING FRAMES OF THE FORWARD WINGS IN PLACE.

FRONT VIEW OF ELLEHAMMER'S FIRST AEROPLANE.



THE AEROPLANE LEAVING ITS SHED.



REAR OF AEROPLANE, SHOWING RUDDERS.

TWO OF THE LATEST FRENCH AEROPLANES AND THE FIRST ONE OF DANISH CONSTRUCTION.

A NEW TYPE OF OSCILLATING-WING MACHINE.

Another one of our illustrations shows the new Coulomb ornithopter, which has recently been constructed by an inventor in Lyons, France. This machine differs from most flapping-wing apparatus in the fact that each wing is pivoted upon two inclined supports at its center, and made to rock upon said support as a pivot, instead of being made to work up and down from one end, similarly to the wings of a bird. Each wing is 6 meters (19.68 feet) long by 3 meters (9.84 feet) wide, and has at each end, arranged in two rows, sixteen cloth-covered frames about 1 by 3 feet in size. These frames are pivoted so that they open and hang down at an angle of 45 deg. with the horizontal when the wing ascends, and close, making a solid structure, when it descends. They make 200 oscillations per minute. Despite the two dead points at each end of the stroke, the apparatus rises, and is propelled forward as a result of the setting of the slats, the angle of which automatically decreases as the machine speeds up. The operating rods connected to the inner ends of the wing run down to vertical chains that pass from the motor shaft up over an idle sprocket, and in this manner they are given the requisite reciprocating motion, which they transfer to the wings. The engine used is a 4-cylinder, water-cooled motor of 40 horse-power. The weight of the machine is 551 pounds and the supporting surface is 386½ square feet. With the two men which it is intended to carry, the total weight is 8[illegible] pounds, and the amount lifted per square foot of supporting surface is 2 pounds, and per horse-power, [illegible] pounds. A speed of 25 miles an hour is expected. As this is the first machine built by M. Coulomb, it is rather rough in construction, the inventor's idea being first to demonstrate his principle, and then to build a better machine. There is a vertical rudder, which is not shown, however, in the photographs. The height of the machine above the ground is regulated by the speed at which the motor is run. The dotted lines show the position of the wings when raised. On account of the location of the wings 10 feet above the motor, the inventor claims great stability for his machine. The apparatus is readily dismountable, and can be quickly taken apart and put together.

This apparatus is a type between that of the aeroplane and the helicopter. As stated above, it is quite different in construction from the usual flapping-wing machine. Possibly it may yet demonstrate its efficiency to be greater than that of the latter type, although this is rather doubtful.

A NEW DANISH AEROPLANE.

One of our illustrations shows the new aeroplane of Mr. Ellehammer, which has lately been constructed and experimented with on the Danish island of Sjælholm, which is located to the south of Seeland, some few miles from the coast of the continent. To house his machine, the inventor built a shed with an opening of suitable shape, so that it could be readily run out when desired. Near this shed he has constructed a long cement track, 23 feet wide by 984 feet in length.

Proceeding in a methodical manner, Mr. Ellehammer has experimented with his machine, and changed it according to the results obtained. Altogether, he has experimented with three different machines, all of which have the same general characteristics, the only difference being in the number of planes. His first aeroplane had but one plane, while the second had two superposed surfaces, and the third three.

The first machine, which was built in 1905, was a monoplane, the two wings of which were triangular in

shape, and were united at the center by a semi-cylindrical portion, as can be seen from the illustrations. The propeller was mounted at the front end of the semi-cylindrical part, and was driven by a belt from the motor placed on the framework below. By placing the motor and aviator below the center of gravity, the inventor hoped to give stability to the machine. Evidently, however, this arrangement did not succeed as well as he expected, for after having tried it for some time with his first two models, he abandoned the semi-circular part. Moreover, it is by quite other means that he has obtained equilibrium and stability in his new machine. In the first place, the center of gravity has been placed extremely low; the motor and aviator are 1.5 meters (4.97 feet) below the sustaining planes and the axis of the propeller. This arrangement stops almost completely the liability of overturning.

In the second machine, the upper plane, which was similar in shape to the lower one, was arched and flexible. The aviator could, at will, lower the upper wings so they almost touched the stationary lower plane; or he could relax them more or less.

Finally, at the rear, besides the vertical rudder, there is a horizontal rudder, which is the most important feature of Mr. Ellehammer's invention. This rudder is automatic. Should the aeroplane, for any reason whatsoever, commence to rise or descend, it tips downward or moves upward, so as to bring the machine back to a horizontal position, although the aviator can voluntarily control its movement in order to obtain ascent or descent. The method of working this rudder is kept secret, but apparently it operates very satisfactorily. If it is really practical and applicable to all aeroplanes, it is evident that it will be a great step in advance, for the longitudinal stability is one of the most serious problems of the modern aeroplane.

As the aeroplane is balanced in a very good manner by the lowering of the center of gravity, the planes can be maintained at a constant angle of about 8 degrees with the horizon, which the inventor has found to be the most efficient angle. The aviator can change this angle at will by turning a wheel, however.

The extra light motors used on these machines were built by the inventor himself. The motor of the first aeroplane was of 9 horse-power, and it drove a 2-bladed aluminium propeller at 500 R. P. M., giving a speed of about 30 feet a second or 20 miles an hour to the machine as it ran along the ground. The total weight was 223 kilogrammes (491.63 pounds) and the supporting surface was 25 square meters (255 1/3 square feet). Hence the loading of the surfaces was 1.92 pounds per square foot. The aviator was mounted on a bicycle saddle behind the motor, as can be seen from the pictures. The aeroplane was mounted on three pneumatic-tired wheels, one of which was used to steer it.

The second aeroplane built by Mr. Ellehammer weighed 275 kilogrammes (606.27 pounds) including the aviator and had 38 square meters (409.03 square feet) of supporting surface, which corresponds to a loading of 1.45 pounds per square foot. The motor was of 18 horse-power. It resembled the first machine largely, the chief difference being that it had an extra, curved-wing supporting surface placed above the main plane, and that the semi-cylindrical center part was done away with. The inventor claims that on the 12th of September, 1906, previous to Santos-Dumont's first flight, he made with his No. 2 machine a flight of about 40 meters (131¼ feet) at a height of about 2½ feet above the ground. Unfortunately, however, he does not bring forward any official witnesses, although the photograph shows that he had a machine which was apparently capable of flying at this time.

The latest machine of this inventor has triple triangular-wing surfaces. The 30-horse-power motor, which weighs only 75 pounds, is mounted above the aviator and drives the propeller, which is directly connected to its crankshaft. It develops its power at 900 R. P. M. The total weight of this latest machine is 205 kilogrammes (451.94 pounds) including the weight of the aviator, which is 176 pounds. This machine, according to various credible witnesses, of whom we might mention particularly Lieut. Ullidtz, is said to have made a considerable number of flights. Those made throughout 1907 and January, 1908, total 194. The longest flight was made January 14 last, and is said to have been 178 meters (584 feet) at about 10 feet height above the ground. One of the photographs shows the machine in flight, and from this it can be seen that the inventor has ingeniously arranged the rear wheel to act as a vertical rudder, the wheel being covered with cloth for this purpose. The latest development has been the removing of the third plane. The machine now has but the two superposed surfaces, and it continues to give good results with these. It is expected that after further experiments and the making of some slight modifications and improvements, it will be possible to take part in some of the long races that are scheduled for this year.

FRAMEWORK AND MOTOR OF THE BERTIN HELICOPTER.

Two vertical shafts are driven through bevel gears from the 150-horse-power, 8-cylinder air-cooled motor.

A NEW FRENCH AEROPLANE.

For a long time, M. Octave Gilbert has studied the problem of flight with a heavier-than-air machine. He began by studying the flight of birds for a number of years, but despairing of being able to imitate it with wings, because there were no sufficiently powerful and light motors, he has adopted an aeroplane with a peculiar form of propeller. This machine was constructed by him according to his own ideas after he had experimented successfully with models having elastic bands or springs as a motive power. A good idea of the aeroplane can be had from our illustration. The aeroplane is constructed of cloth and bamboo, and has somewhat the form of a bird. It is mounted on a chassis of wood with pneumatic-tired wire wheels, and is permanently set at a suitable angle with the horizontal. The wings are curved slightly downward at the ends. There is a stationary tail which also curves upward. As this tail is stationary, the inventor has rigged a diamond-shaped vertical rudder above the aeroplane, for the purpose of steering it, while a triangular horizontal rudder is pivoted to the forward edge of the main plane. The operator sits upon a saddle above the rear wheel, which he turns, in order to steer the machine, by means of a bicycle handle-bar. The vertical rudder is interconnected with the handle-bar, so as to turn in unison with the rear wheel. The motor and propeller are mounted upon a substantial frame and connected through gears. According to the claims of the inventor, the single-cylinder, water-cooled, 6-horse-power engine drives the peculiar S-shaped propeller 800 R. P. M. with the development of 180 kilogrammes (396 pounds) thrust. This figure corresponds to a thrust of about 66 pounds to the horse-power, which is about six times the thrust usually obtained. The total weight of the machine is some 45 kilogrammes (99 pounds). The spread of the main plane is about 8 meters (26 feet) and its width from front to back is 1½ meters (5 feet). The tail is in the form of a pentagon 3½ meters (10½ feet) wide by 1½ meters (5 feet) long.

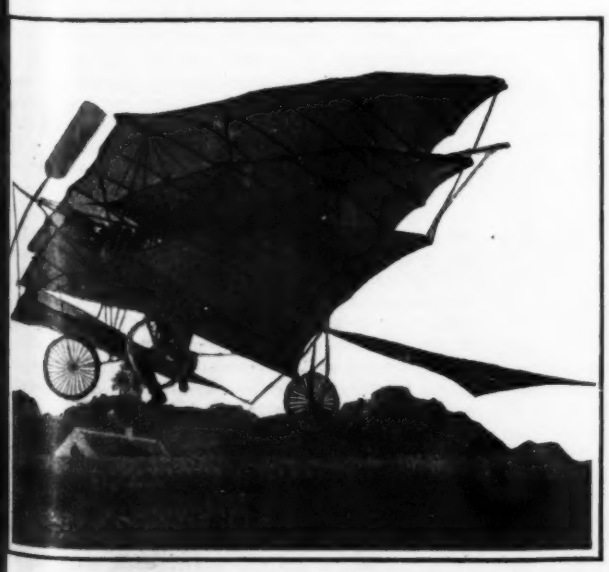
The machine can be readily dismounted into three parts, and requires only ten minutes' time to reassemble. At the first test, the pinion on the motor broke. Nevertheless, the machine is said to have flown a distance of about 300 feet, but the propeller unscrewed, and the aeroplane dropped to the ground without any shock. The propeller turned to the left and tended to unscrew; consequently, as there was no jam-nut, it loosened. Its speed of 500 R. P. M. was insufficient, but the first trial showed that the aeroplane was able to rise simply by the force of the wind blowing against it and without being driven by its propeller. As the triangular, horizontal rudder was held down only by a piece of iron wire, the wind bent it upward, and raised the whole machine, turning it over backward.

The inventor hopes to experiment further with a more powerful motor placed at the front of the machine and carrying the propeller upon its crankshaft. He will move back the tail to a distance of 3 meters (9.84 feet) from the wings, and, by means of a transverse bamboo pole 4 meters (13.2 feet) long, he will fit two rectangular cells 1½ meters (5 feet) long by 1 meter (3.28 feet) wide, so as to balance the back and give stability.

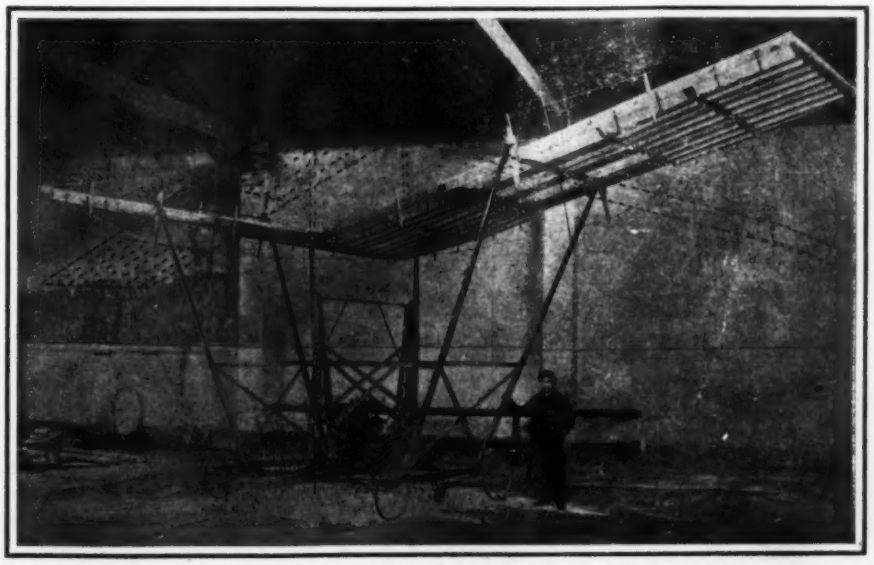
The total supporting surface of the machine as shown is 16 square meters (172¼ square feet), while its weight is about 45 kilogrammes (about 100 pounds). Including the weight of the operator, this would make a loading of the surfaces of about 1½ pounds to the square foot, which is quite moderate.

One of the illustrations shows the new Farman aeroplane in process of construction. The body framework is shown with the front wings attached, while the general appearance of the machine can be seen from the diagrams.

The body framework is 14 meters (45.93 feet) long over all, including the vertical rudder. Attached to it on each side at the front are three planes arranged in steps, while there are two on each side at the rear.



THE THIRD ELLEHAMMER AEROPLANE IN FLIGHT.



THE COULOMB OSCILLATING-WING FLYING MACHINE.

THE LATEST DANISH AEROPLANE AND A FRENCH HELICOPTER AND OSCILLATING-WING FLYING MACHINE.

The spread of all the planes is 7 meters (22.96 feet) while their width is 1.3 meters (4¼ feet). The total supporting surface is about 27 square meters (290.62 square feet), which corresponds to a loading of the surfaces of 5 pounds per square foot, if we consider the weight of the machine as 650 kilogrammes (1,433 pounds)—a figure which it will probably exceed. A glance at the photograph will show the comparatively small size of the front supporting planes. The rearmost pair of planes on the tail turn and act as a horizontal rudder. M. Farman proposes to equip his new machine with either a 50-horse-power Renault, 8-cylinder, air-cooled motor, or with an 8-cylinder, 80-horse-power, Antoinette motor. The speed at which the machine should rise is calculated to be 80 kilometers, or 50 miles, an hour. While M. Farman may succeed in flying with this machine, one can readily see that it will be a difficult matter to attain the requisite speed for soaring, and that when he is once in the air, the machine will probably lack stability. Should it upset at any such speed, the aviator runs a far greater chance of serious injury than with those aeroplanes that have already met with disaster while traveling at a speed of about 30 miles an hour.

THE ARC AND THE SPARK.

THEIR USE IN WIRELESS TELEGRAPHY.

BY W. DUDDELL

THERE are three methods of producing these currents—namely, the alternator, the spark, and the arc methods. There are great difficulties in the way of constructing an alternator to give such high-frequency currents. Suppose that it is required to build an alternator to work at the lowest frequency—namely, 100,000 periods per second—and let us assume that we can drive this alternator by means of a turbine at the high speed of 30,000 revolutions per minute. This alternator could not have a diameter much above six inches for fear of bursting, and, as it makes 500 revolutions per second, it would have to generate 200 complete periods for each revolution, so that the space available for the windings and poles for one complete period will be less than 0.1 inch, a space into which it is quite impossible to crush the necessary iron and copper to obtain any considerable amount of power. In spite of the small space that we have allotted to each period, as there are 100,000 periods per second, the speed of the surface of the moving part works out at over 500 miles per hour. A small alternator has been built to give over 100,000 frequency, but the amount of power it produced was extremely small.

The earliest method of producing high-frequency oscillations was proposed by Lord Kelvin, who pointed out that if a Leyden jar, or condenser, be allowed to discharge through a circuit possessing self-induction, or electrical inertia, then, under certain conditions, the discharge of the jar is oscillatory—that is to say, that the electricity flows backward and forward in the circuit several times before the jar or condenser becomes finally discharged. In practice the aerial conductor acts as a Leyden jar or condenser. It is charged with electricity and allowed to discharge, the current oscillating backward and forward in the aerial during the discharge. In many installations Leyden jars or condensers are electrically connected to the aerial, so that the oscillations taking place in them are transmitted to the aerial. For wireless telegraphy it is usual to charge the condensers, or aerial, by means of an induction coil, or an alternator, to a very high voltage, and it is allowed to discharge by means of a spark between the two electrodes which form the ends, so to speak, of a gap in the electrical circuit. As long as the pressure is low the spark-gap is a perfect insulator; when the pressure becomes high enough the air between the electrodes breaks down and a spark passes, the gap becomes a conductor, and allows the condenser to discharge. The property of the spark-gap of passing almost instantaneously from a condition of being an insulator for electricity to being an extremely good conductor for electricity is of the utmost value in the spark method of wireless telegraphy. The more perfectly the spark-gap is insulated before the discharge takes place, and the more perfectly it conducts after the discharge has taken place, the better it is for our purpose.

If a large quantity of electricity is discharged through the spark-gap, and if the spark lasts a very short time compared with the interval between successive sparks, then a highly conducting spark can be obtained, as well as a good insulation between the sparking terminals when no discharge is passing. In order to help to bring the gap back to its insulating condition after each discharge, many devices are employed, such as subdividing the spark into several shorter sparks, cooling the electrodes, blowing air across the spark-gap, etc. When the condenser, or antenna, discharges through the spark-gap, oscillations are set up which radiate Hertzian waves. In practice, in wireless telegraphy, it is difficult to obtain a large number of oscillations during each discharge. A large number of oscillations means, if we keep the amplitude of each the same, that we are radiating a large quantity of energy. Besides this radiated energy, which is useful for transmitting messages, there is also energy wasted in heat in the spark-gap, in the conductors, in the glass or other insulation of the condensers. It is this useless part which we require to make as small as possible. I have lately had an opportunity to determine how many oscillations actually take place in a certain wireless transmission. The experiment was made by photographing the spark as seen in a mirror rotated at a very high speed, and it was found that each spark consisted of nine or ten complete oscillations. If all the oscillations had been of equal strengt.. or amplitude, then there would be very little to be gained by increasing the number of oscillations. As the oscillations die away in the spark method, two or three times this number would probably be required for the best effect. As a matter of experiment, very good tuning has been obtained.

The arc method of producing continuous oscillations is founded on my musical arc. In order to explain this I must demonstrate some of the properties of the direct-current arc. If I vary the current flowing through the arc very slowly and note the potential difference corresponding with each value of the current, keeping everything else constant, I obtain a curve generally spoken of as the characteristic of the arc. With the carbon arc between electrodes in air the voltage decreases very rapidly when the current is gradually increased, starting from very low values. As the current becomes larger the rate of decrease of the voltage becomes less and less, until it is, comparatively speaking, quite small, with a current of ten or twelve amperes. With the arc between metal electrodes similar results are obtained, except that the discontinuity in the curves, called the hissing point, takes place at very small currents, generally well below an ampere. With arcs burning in hydrogen, Mr. Upson has found that the curves are generally much steeper for the larger values of the current than for the corresponding arc burning in air. This point is of great importance as explaining the value of the hydrogenic atmosphere used by Poulsen and referred to later. In general, I may, therefore, say for the above arcs that increase in current through the arc is accompanied by decrease of potential difference between its electrodes, and, *vice versa*, decrease of the current causes increase in the potential difference. On the other hand, certain arcs, such as the arc between cored carbons, behave in an opposite manner—that is to say, current and potential difference increase and decrease together.

I demonstrated in 1900, that if I connected between the electrodes of a direct-current arc (or other conductor of electricity for which an increase in current is accompanied by a decrease in potential difference between the terminals) a condenser and a self-induction connected in series, I obtain in this shunt circuit an alternating current. I called this phenomenon the musical arc. The frequency of the alternating current obtained in this shunt circuit depends on the value of the self-induction and the capacity of the condenser, and may practically be calculated by Kelvin's well-known formula. Besides the condition that an increase of current must be accompanied by a decrease in potential difference, it is necessary that the relative decrease in potential difference, produced by a given increase in current—that is to say, the steepness of the characteristic—shall exceed a certain minimum value, which depends on the losses in the shunt circuit. It is also necessary that an increase in current shall be accompanied by a decrease in potential difference, even when the current is varied very rapidly.

At the moment of connection of this shunt circuit to an arc, a current flows from the arc circuit into the condenser circuit which tends to reduce the current flowing through the arc. This reduction of the current through the arc tends to raise the potential difference between its terminals, and causes still more current to flow into the condenser circuit, resulting in a condenser charged above the normal voltage of the arc. The condenser, therefore, begins to discharge through the arc, which increases the arc current and decreases the potential difference, so that the condenser discharges too much; the reverse process then sets in; the condenser becomes successively overcharged and undercharged, due to the fact that, instead of the potential difference between the terminals of the arc remaining constant and allowing the condenser to settle down with its proper corresponding charge, the potential difference actually decreases when the condenser is discharged and increases when it is charging, so as to help to keep up the flowing backward and forward of the current indefinitely. Oscillograph wave-forms show what is going on very clearly, and they show that in general the swing of the current in the condenser circuit attains such a magnitude that when the condenser is charging it takes the whole of the current away from the arc, so as to make the arc, although burning on a direct current, a pulsatory arc. The pulsation of the current through the arc causes the vapor column to grow bigger and smaller and displaces the air around it and produces a note the pitch of which is determined by the frequency of the current in the shunt circuit.

For wireless telegraphy, by means of Hertzian waves, based on the arc method, we require high frequencies in the shunt circuit. If we attempt to obtain this high frequency from the ordinary arc, burning between solid carbons in air, we find that above a certain limit the oscillations will no longer take place. This is due to the fact that we are varying the current through the arc, at this higher frequency, too quickly for an increase in current to be accompanied by a decrease in potential difference. I have demonstrated that if I only vary the current through the ordinary current arc sufficiently rapidly, then an increase in current is accompanied by a proportionate increase in the potential difference, and the arc behaves just like an ordinary resistance. If we work with very small current arcs we can obtain high-frequency musical arcs burning in air between carbon or metal electrodes.

In both the arc and the spark methods of wireless telegraphy we employ a high-frequency alternating current in the aerial conductor. The essential difference between the two methods lies in the fact that with the spark method our alternating current in the aerial conductor first increases to a maximum value and then dies away rapidly making only a limited number of oscillations whereas in the arm method the oscillations are maintained continuously of unvarying amplitude. With the arc method we are further able to choose the number of consecutive oscillations which make up each signal sufficiently great to obtain the very best syntony. On the other hand improvement in the arrangement and construction of the apparatus for the spark method has so increased the number of oscillations corresponding with each spark that it may be that we shall be able to obtain a sufficient number in each train to give as good syntony by this method as that obtained with the arc method. The arc method seems eminently suitable for very high speeds of working. As the oscillations are quite continuous, we can cut them up into groups to form the dots and dashes of the Morse alphabet, just as if we were working with a continuous current such as is used on land lines, so that there seems no reason why as high a speed of working should not be obtained from the arc method of wireless telegraphy as is obtainable by automatic signaling on land lines; for it is to be noted that the dot, or shortest signal of the Morse alphabet, even at a speed of 300 or 400 words per minute, will last long enough to consist of many hundreds of oscillations of the current in the aerial, so that there will be plenty of oscillations in the group forming the dot to give good syntony.

Turning to the spark method for high working speeds, we find a difficulty in that the dot of the Morse alphabet must at least occupy the average time required to charge the condenser or aerial and produce one spark, and preferably sufficiently long for several. We are, therefore, obliged, in the spark method, to use a high rate of sparking for high-speed signaling. This difficulty has not become very serious with the present low speeds of sending. When we come to use considerable amounts of power to transmit messages over long distances, and we also require a high speed of working, the practical difficulty in constructing apparatus suitable for sufficiently rapid sparking will become serious. Marconi, in 1905, claimed to have already reached a speed of 100 words per minute by the spark

* Evening discourse delivered before the British Association for the Advancement of Science, at the recent Leicester meeting. Abstracted.

method, and lately there has appeared in the technical press examples of high-speed signaling by the British post office over a distance of fifteen miles in which readable signals were received at a speed of seventy words per minute.

Turning to the receiving end almost all the receivers that have been used in the spark method can be equally well used for the arc method; for it must be remembered that the transmission in either case is effected by Hertzian waves traversing space and that the only fundamental difference consists in the number of oscillations in each train of waves. It must be noted, however, that in those methods in which a telephone receiver is used, it is necessary to break up the continuous oscillations of the arc method into groups succeeding one another sufficiently rapidly to produce an audible sound in the receiver, for in the spark method the sounds we hear in the receiver correspond with the succession of impulses of the diaphragm, one for each spark at the transmitter. This chopping up of the continuous wave-train so as to produce audible signals in the receiving apparatus can be done either at the transmitting end or in the receiving apparatus. An example of this latter method is Poulsen's "tickler."

An extremely interesting development which is now progressing rapidly, owing to the possibility of producing continuous oscillations by the arc method, is wireless telephony. Suppose that we can vary the intensity of the oscillations in a manner corresponding with the vibrations of the air which constitute sound and speech, then we should obtain at the receiving stations a train of Hertzian waves whose amplitude varies in a corresponding way; by allowing these waves to act on a telephonic receiver which is sensitive to the intensity of the waves we shall obtain in the telephone a reproduction of the sounds. This has actually been carried into effect by employing an ordinary microphone to modify the current through the transmitting arc so as to vary the intensity of the oscillation current produced, and by employing what is known as a "point detector" and telephone at the receiving station.

Another method which may be used consists in causing the microphone to vary the frequency of the oscillation of the generator, and by arranging the receiver so that it is more or less strongly affected according to the frequency of the received waves.—Electrical Review.

THE TECHNOLOGY OF MOLASSES.

ITS UTILIZATION IN THE ARTS.

BY DR. THEODOR KOLLER.

MOLASSES is used in the manufacture of spirits. Its value is governed by the amount of sugar it contains. In investigating molasses as to its value, we dilute it, for instance, to 18 deg. on the ordinary saccharometer, set it to ferment at 75 deg. to 77 deg. F., transfer it to a warm place and allow it to ferment out. If the saccharometer shows, for instance, 3 deg. unfermented, it is evidence that, in an 18 deg. fluid, owing to the fact that the presence of the alcohol produced by fermentation causes the saccharometer to sink deeper, there is 15 deg. of sugar present, or, in a molasses that reads originally 45 deg., 37½ deg. To determine the actual amount of sugar, boil the fermented fluid, driving off the alcohol it contains. Replace the volumetric loss with distilled water, weigh it again, and the percentages which the instrument then shows are those really unfermented. If, for instance, the instrument reads 19 deg. before fermentation, in the unboiled, fermented mixture 4 deg., in the boiled fermented 5½ deg., there are really only 13½ fermentable degrees.

The molasses consists of sugar, salts, non-nitrogenous and nitrogenous compounds, alkalies and alkaline earths. The latter tend to retard the fermentation. To relieve the restrictive influence on the fermentation, we add to the molasses, according to its requirements, ½ to 1½ per cent of sulphuric acid. A regular mashing does not take place with molasses, but according to the degree of its density it is entered, somewhat diluted, into the first mash tub, into which the sulphuric acid, diluted with water, has previously been admitted. The molasses is heated until it no longer gives off an acid odor. Acid, as a rule, is to be used only where the molasses shows an alkaline reaction. Should this be the case, acid is added until blue litmus paper is colored a faint wine red. It is advantageous to admit the water to the fore-mash tub in advance and to complete the mash there, because the admission of water into the fermenting tub causes considerable difficulty in stirring in the molasses. The mixture of molasses and water must be an intimate one and as molasses mixes with difficulty with water in a cold condition, heating in the fore-mash tub is an advantage in obtaining this mixture. A surface cooler is necessary in molasses factories. Whether sulphuric acid or hydrochloric acid is used in largest quantity depends on the result of the fermentation of the molasses. As a rule after neutralization with sulphuric acid, in tubs containing 90 to 100 pailfuls from 1 to 2 pounds of hydrochloric acid are added. Some molasses does not require any hydrochloric acid; the largest proportion is used in the factories that work with beets grown on heavy, wet soil or on uncultivated lands. Usually we take of hydrochloric acid about 5 to 10 per cent of the quantity of sulphuric acid obtained.

In molasses mashes, we employ generally an exceedingly green malt yeast, to which every-day beer yeast or compressed yeast must be added, because the molasses mash fermentation is very difficult. We may reckon ten per cent of yeast. In addition it is desirable to conduct a very vigorous first-fermentation. Soon after pitching, the molasses mash will show a head 3 or 4 inches high, under which, if the process is well managed, a very active fermentation will be in progress. The tubs are filled to allow 2 to 3 inches of rising room and the mash is pitched at 86 deg. to 111 deg. F.

If we have the beet juice we can use it to dilute the mash. Where a tub does not start fermentation actively, it should be helped by adding beer yeast or by raising the temperature. Care must also be taken to insure a temperature of 72 deg. to 77 deg. F. It is best, as these mashes cool off very rapidly and are then difficult to ferment, to set up one or two stoves in the fermenting chamber, in which fire can be made in the winter months.

The swill, in country distilleries, in part, mixed with other substances, is employed as cattle feed and in part it is used for fertilizing. In larger distilleries it is boiled down in so-called evaporating pans and then transferred to calcining furnaces constructed on the plan of soda furnaces. As a rule, three furnaces are employed, arranged terrace like, one above the other, and the molasses is run from one into the other; in the last carbonization is effected. According to the quality of the molasses, we thus obtain from 11 to 12 per cent of molasses carbon, which contains about 50 per cent of carbonate of potassium. The free acid in the swill is often neutralized by means of lime, which is allowed to settle as sulphate of lime, and the swill, after being concentrated in the evaporating pans, is transferred to the above mentioned calcining furnaces, for the destruction of the organic substance.

If fed to cattle in large quantities molasses swill is likely to cause diseases.

Where potatoes are to be worked up with molasses, it is best to mash them mixed together and the mixture should take place in the saccharification; during the grinding of the potatoes, the finished molasses mash should be saccharifying; if, however, there are no arrangements for the preparation of a molasses mash, this may be effected in the saccharification and the potatoes are ground into it.

The best proportion in this event is to use 2½ to 3 hundredweight of 42 deg. molasses for each 25 hundredweight of potatoes. The manipulation remains the same as in potato mashing, only the proportion of yeast must be increased. Where this process is employed the swill can be used safely for feeding.

Camille Vincent has perfected a process for the practical utilization of the residue remaining after the distillation of alcohol from beet sugar molasses, the so-called vinasse.

Previously, this had been calcined on open fireplaces, to obtain the potash salts it contained. The idea of utilizing the resultant gaseous products was, it is true, agitated for years before, but was only realized later by Vincent.

According to his process, the calcination is effected in cast-iron retorts; the distillation products set free at ordinary temperatures and consisting of tar and ammonia water, are collected, whereas the remaining gaseous portion is conducted away for use in heating the retorts. The ammonia water resembles generally that obtained in gas making by the dry distillation of coal, but contains, in addition to the usual constituents, methyl alcohol, methyl cyanide, methyl sulphide, and what is especially noteworthy, large quantities of trimethylamine salts.

The alkaline, aqueous distillation product, according to further information in a pharmaceutical paper, is first saturated with sulphuric acid and distilled; methyl alcohol is distilled off; from the residue, on cooling, sulphate of ammonia crystallizes out; the mother lye contains particularly sulphate of trimethylamine.

The trimethylamine has intrinsically no special commercial value; it is, however, very well adapted for the production of chloride of methyl. If, for instance, the muriate or hydrochlorate of the trimethylamine is heated, it is decomposed into ammonia, free trimethylamine, and chloride of methyl.

The decomposition commences when the boiling point of the concentrated mother lye of the trimethylamine reaches a temperature of 260 deg. and is completed at 295 deg. C.

The gaseous product is conducted through hydrochloric acid, which holds the alkaline products; from the hydrochloric acid solution the sal-ammoniac is then, after separation by evaporation and crystallization, subjected to another distillation.

The methyl chloride that passes over, after it has been purified by washing with dilute soda lye, is dried by the aid of concentrated sulphuric acid in iron or copper cylinders, fitted with screw closing valves, made liquid in these by pressure, and shipped in this form.

The value of methyl chloride for technological purposes is twofold; in the first place it is very well adapted for use in artificial refrigeration; on the other hand, it serves for the production of methylated aniline colors, which was formerly costly, owing to the use of iodide of methyl.

In the evaporation of methyl chloride the temperature is reduced to —13 deg.; if, however, the rapidity of evaporation is increased by the passing of a current of dry air, the temperature recedes to —55 deg. Methyl chloride is consequently an excellent medium for ice machines.

In the great distilleries of Tilloy, Delamine & Co., at Courriere, which were under Vincent's management, 90,000 kilogrammes of molasses are used daily, from which 25,000 liters of pure alcohol, of 90 deg. strength, with a residue of 40,000 kilogrammes of vinasse, are obtained; this yields 10,000 kilogrammes of potash salts and as the product of condensation, on the one hand, 1,600 kilogrammes of sulphate of ammonia, 100 kilogrammes of methyl alcohol, and 1,800 kilogrammes of concentrated mother lye of trimethylamine salts; and on the other hand 4,000 kilogrammes of tar from which 360 kilogrammes of oil and 2,000 kilogrammes of aqua ammonia are distilled.—Translated from Handbuch der Verwertung, etc., von Abfallstoffen aller Art.

PLATINUM RESIDUES.

THE use of platinum paper is very general among photographers, and the present high price of the metal —it is considerably dearer than gold—makes the recovery of waste a profitable investment. In a platinum print the dark tones are platinum and in the lighter shades the platinum is particularly dissolved out; the white parts are pure paper, free from platinum. Thus in many prints 50 per cent of the platinum is dissolved out, and where white backgrounds or vignettes are used, or where prints are made in a delicate gray, the proportion is more. Most of this platinum is dissolved into the first acid water and this, together with spent developer, is well worth the saving. Get an eighteen-gallon keg—or better, a stoneware jar—and empty the solutions into it. Suspend some pieces of sheet zinc in the jar by a stout string, letting them hang free from the sides, and two or three inches above the sludge which collects. In ten or twelve hours the solution will probably be colorless; if it is still yellow a little muriatic acid will precipitate the platinum. Scrape the zinc clean, and in a few hours precipitation will be complete. Carefully decant the colorless liquid and throw it away; but do not disturb the sludge which has formed at the bottom of the keg. When a quantity of sludge has been recovered strain it through a cloth, letting the drippings return to the keg, and send the dry sediment to the refiner.

Mixture to Make Casks Tight (Schattels and Klein).—*a*. Vaseline 15 parts, paraffin 5 parts, gutta percha 1 part are melted together and mixed with 35 parts of kaolin. *b*. Tallow 42 parts, lard 67 parts; mix with 42 parts of finely sifted wood ashes.

SCIENCE NOTES.

Taking into consideration the serious damage caused by fire at previous exhibitions, the executive committee of the Turin International Exhibition of 1911 has decided to open an international competition for preparations best adapted to render incombustible the wood and cloth structure of the exhibition, and will award a prize of 4,000 lires and two gold medals and two silver medals in this connection. The preparations must be such that they can be applied without visible alteration of the color and resistance of the materials.—Science.

The rare element neon has been found by H. P. Cady and D. F. McFarland in natural gas from southeastern Kansas, along with helium. It is separated in pure condition by fractional absorption in bulbs filled with cocoanut charcoal and cooled with liquid air. The neon is identified by careful measurement of the lines of the spectrum and comparison with best published measurements. All of the stronger lines have been identified. Besides the lines of neon fifteen fairly strong lines are found which can not be identified as belonging to any of the familiar gases. These same lines have previously been reported by Dewar in the spectrum of the gas from Bath Springs and also in lists of the lines shown by the more volatile gases from the atmosphere. It is possible that these may represent a new elementary gas.

According to strength tests made by Dr. Meylan, the physical director of Columbia University, the total average strength of the men who smoke exceeds that of non-smokers by eighteen kilogrammes. Six hundred and eighty-seven new students entered Columbia during 1907-1908, and of the number examined 90 per cent were freshmen and the others in the law and graduate schools. Dr. Meylan also inquired into the freshmen's temperance ideas, and found that out of the 687 examined, only 141, or 25.8 per cent, used intoxicants, while 546 or 74.2 per cent were teetotalers. The total number answering about tobacco were 683 students, of which number 205, or 30 per cent, were addicted to the weed, whereas 478, or 70 per cent, never had smoked anything stronger than corn silk. A peculiar feature of the comparison is that the smokers developed more power in their strength tests than the non-smokers. Dr. Meylan attributes this apparent advantage of the smokers to the fact that the average age of the men was one year and two months more than that of the non-smokers.

Messrs. Trillat and Turchet recently published a method for the detection of ammonia in water, based upon the property which nascent iodide of nitrogen possesses of giving the water a characteristic black color. M. Corsini has repeated these researches with care and obtains practically the same results. He observes that the limit of sensitiveness of the method varies between 1.75 and 2 per 500,000. He considers the following to be the best method of operating. We add to 15 or 20 cubic centimeters of the water to be examined, three or four drops of iodide of potassium solution of 1 per cent strength, then agitate and let fall successively three drops of chlorine water, taking care to observe the water after the addition of each drop. In presence of ammonia, there is formed a slight black cloud which cannot be confounded with the light yellow tint coming from the setting free of a small quantity of iodine. In conclusion the author, who experimented on a great number of cases, recommends the use of the above method for two reasons, first because it is more sensitive than the Nessler process in presence of certain bodies which hinder that reaction, and second because it utilizes substances which are found in all laboratories, while the Nessler reagent is difficult to prepare and changes after a time.

Some curious phenomena have been observed by Tornier in the case of the frog and tadpole. The larvæ of the *Pelobates fuscus* will feed indifferently in the natural state upon animal or vegetable food. Tornier observed that when we experiment upon embryos which have just left the egg, and suppress all animal food, they will eat the thread-like algæ which cover the sides of the aquarium, but they soon die under this treatment, and have the body curved in a characteristic manner. If we give to the embryos a food which is animal and vegetable at the same time, up to the time when they show rather well-developed hind legs, and then after this we cut off the meat food, such tadpoles will continue to live, but they are found to undergo a complete stop in their development. At the end of a year they still remain in the larva stage and thus offer an example of persistence in the larva state which is of some interest. On the other hand, by suitably varying the diet which is allowed the specimens, Tornier was able to obtain adult animals whose pigmentation was black, red or gray as he desired, or again he obtained perfect albinos. If we feed the larvæ abundantly with meat, they become quite black and are transformed into black adults. If, on the contrary, we allow the larvæ only the strict minimum of meat food, we obtain specimens which have no pigment whatever, and ion-yellow hue. Between these two limits, the animal food in greater or less proportions is found to give colors of the specimens which vary from gray to cinnabar red. Tornier's experiments are of interest, not only because they show the influence of a greater or less amount of animal food upon the pigmentation of the skin, but also because they throw some light upon the disputed question of the physiology of pigment. According to Tornier's interpretation, the pigmentary granules constitute a reserve which the cell utilizes according to its requirements. This may explain why the pigmentary cells, which have a dark color when in a state of rest, become pale in the state of functional activity and in the state of inanition.

ELECTRICAL NOTES.

A correspondent of the Chicago Daily News who had his interest in electric cooking excited by the exhibit of apparatus at the recent Electrical Show, suggests that an electric piano be attached to the electric stove in order that when certain dishes are in preparation the piano will cheer the cook by playing an appropriate tune. A long list of tunes is given; to accompany the cooking of potatoes, "Melodies of Ireland" is suggested, and for frying sausages, "Broken Links" is offered as appropriate.

The Chinese delegate to the International Telegraph Union's convention at Lisbon next April is Chow Wanpang. China has heretofore refused to join the union, and her representation is to be unofficial, but the government thinks that recent improvements in telegraphic communication may make it possible to subscribe to the international regulations. Li Hung Chang was the father of China's telegraph system, which since 1881 has expanded to embrace sixty thousand miles of working lines.

The "Home Show" will open at the Grand Central Palace, New York, on May 2 and run for a week. As the name indicates, the show will be devoted to the home, and to all things in the constructive, decorative and furnishing lines that pertain to the home. A special effort is being made to obtain the best and latest electrical devices and conveniences for exhibition, and the application of electricity as used in a hundred ways in the up-to-date house will be fully demonstrated. An invitation to architects, builders and contractors to attend the show as guests of the management will be extended and special efforts will be made to obtain their co-operation. William Horwood is president of the Home Exhibits Company, which has the exhibition in charge; I. L. Wilfong is vice-president; and G. C. Horwood, secretary.

During recent years the use of electricity for power purposes in docks has been greatly extended, and as the power companies, now feeling their way, develop their business, it is probable that a still greater extension will take place. Electricity offers many advantages over the hydraulic system (which has up to recent times held this field almost exclusively), especially in places where electric power can be obtained at a reasonable rate from an outside source, and the user has not to incur the heavy capital expenditure involved in the provision of a generating station for the exclusive supply to the dock premises above. It is generally admitted that, where a reliable supply can be obtained from an outside source, as in the Tyne district, it is much more advantageous to take supply from that source than to generate for such loads as are obtained in docks where the total consumption is small and the maximum demand large.

The new rack-rail electric line which is to pass up the side of Mont Blanc will be one of the most interesting pieces of work of the kind which has been undertaken in the Alpine region, and owing to the magnificent view which is to be obtained from this elevated point it is likely to prove a favorite with tourists. The mountain line begins at Chamonix, which is the terminus of an electric railroad now in operation for some years past and which starts from Fayet. Owing to the character of the mountain slope, a considerable amount of work had to be carried out by the engineers in constructing the road-bed for the line. As the slope is too great to be covered by an ordinary electric road it was decided to use the rack-rail system, such as is adopted upon many of the mountain-climbing roads in Switzerland. The upper end of the line lies at Montanvert, which has an altitude of 1,921 meters (6,302 feet). Tourists will now be able to enjoy the superb view from this point without the fatigue of climbing the mountain. From here is seen the whole extent of the enormous glacier known as the Mer de Glace, with the imposing peaks of the Aiguille Verte (13,630 feet) and Aiguille du Geant (13,250 feet). Far in the distance is to be seen the Charmon peak. From Chamonix it is estimated that the first part of the Mer de Glace can be reached in fifty minutes; at present the journey by mule or on foot requires more than two and a half hours. It is expected to have the new line completed and open for traffic in the month of July, and it will probably no doubt be one of the best patronized mountain roads in the Alpine region.

TRADE NOTES AND FORMULÆ.

Files of aluminium steel are made by adding a little aluminium to the cast steel, which imparts to it great hardness and elasticity.

To Silicify Casks (Impregnation with Soluble Glass).—Soak the wood with a solution of sulphate of magnesia, ratio 1 : 10; then rinse with a mixture of soluble glass, 30 deg. B., and water in proportion of 1 to 3.

Carriage Priming Color, Surfacer or Filler.—Apply with a spatula 16 parts of white lead, 15 parts of dark umber, 20 parts of chalk, 30 parts of heavy spar, 12 parts of siccative, 5 parts of oil of turpentine, and 20 parts of linseed oil varnish ground in a paint mill.

Alloys for Taps (according to Vigoureux).—

	I.	II.	III.
Tin	78.5	80.7	71.3
Antimony	19.5	17.5	21.5
Nickel	2.0	1.8	7.0

I. is for the body of the tap, II. for the spigot of the plug, and III. for the bushing of the plug.

To Harden Files.—200 parts of common salt, 10 parts crushed white glass, 75 parts of neatsfoot burned and pulverized, 25 parts of rye flour, 25 parts of rosin, 20 parts of charcoal powder, 12 parts of ferro-cyanide of potassium pulverized, made into a paste with alcohol, applied to the files as a coat, which are then dried and placed in the fire. After heating, introduce vertically into the hardening water.

Smoke Cartridges for the Destruction of Field Mice.—12 parts nitrate of potash (potash-niter) dissolved in 24 parts of hot water thoroughly mixed with 30 parts of sawdust and 7 parts of coal tar, dried in the air, mixed with starch paste (about 10 per cent starch and 90 per cent water) into a mass, divided into pieces of about ½ inch thick and 1¼ inch long, well dried and coated with melted sulphur.—Bersch.

To Prevent Fat for Perfumers Becoming Rancid.—Mix 100 parts of melted and strained fat with 0.5 part of pulverized salicylic acid, or 0.5 part of sublimated benzoic acid, or 1 part of finely pulverized benzoin. In the two latter cases the fat is also perfumed and can either be used as it is as a hair pomade, or by the addition of other perfumes, made more odoriferous, and colored if desired.

Grease Spots.—Benzol-magnesia is an excellent medium for the removal of grease spots from paper. Calcined magnesia is mixed with sufficient pure benzol until a mass is obtained that is after some time friable. A little of this substance is carefully rubbed with the finger on the grease spot and the small crumbs of magnesia shaken off. Fresh spots usually disappear at once, older ones after a short time, especially if the benzol-magnesia is applied three or four times and then shaken off. The benzol-magnesia must be kept in glass bottles with well-ground-in glass stoppers.

Window Transparency of Pressed Flowers.—On a sheet of ground glass, gum a spray of dried flowers, ferns, grasses, etc., suitably disposed and enlivened by the introduction of butterflies, dragon flies, spiders, etc. A second transparent sheet of glass is laid over this and both are clamped together by means of a brass edging on which there are two ears which serve for its suspension; or, we can paste paper around the edges with the aid of warm glue. The dark red and yellow autumn leaves produce a very pretty effect, especially where they are very much divided, as for instance in the case of geranium leaves, etc.

To Detach Glazing Putty Readily.—The putty is softened by means of caustic potash. Potash (carbonate of potash) is pulverized and mixed with as much freshly-burned lime, the latter being caused to crumble into powder by spraying it with water. The mixture is made into a liquid paste by the addition of water and is then painted over the hard putty several times until it softens. In order that the mixture may not dry out too readily, a little soft soap can be mixed with it. After the putty has been softened, it can be very readily detached.—Bersch.

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